DAVIESS-MARTIN COUNTY JOINT
PARK AND RECREATION BOARD

WEST BOGGS LAKE ENHANCEMENT DESIGN PROJECT

VOLUME II

INSPECTION PLAN
OPERATIONS AND MAINTENANCE PLAN
POST CONSTRUCTION MONITORING PLAN
DESIGN PROJECT REPORT
PERMIT DOCUMENTS

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COMMONWEALTH
ENGINEERS, INC.

VOLUME II

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2a. Overall Description of Project and Quality Control Plan

Description

The projects are designed to enhance the area, volume, and function of existing wetlands in each of the two project areas. They will serve to trap sediments and to facilitate nutrient uptake from the incoming water by plants.

There are two primary activities in each project area. The Area 1 project consists of installing a pile of shot rock into the unnamed creek channel, to encourage flow distribution over a broader area of the enhanced wetlands, and the construction of a driven steel sheet piling dam with stop log outlets (constructed of steel H-beams and wood stop logs) in front of the existing pipe arch beneath St. Mary's Road. This is to raise the water elevation in the existing wetlands (west of St. Mary's Road) from 499.6 feet above mean sea level (MSL) to 502 feet above MSL. Rip-rap will be placed in high energy areas for erosion control.

The Area 2 projects also include a pile of shot rock dumped into the Shurn Creek channel to encourage flow distribution over a broader area of the enhanced wetlands, and downstream, the construction of a driven steel sheet piling dam with stop log outlets (constructed of steel H-beams and wood stop logs) to increase the elevation of incoming water to increase the area and volume of the existing wetlands. The water level upstream of the dam will be increased from an existing 499.6 feet above MSL to a proposed 501.3 feet above MSL. Rip-rap will be placed in high energy areas for erosion control.

Quality Control Plan

The Contractor shall provide and maintain an effective quality control program. This program shall establish a means to perform sufficient inspection and tests of conformance to applicable Specifications and Drawings with respect to the materials, workmanship, construction, finish, and functional performance. This control will be established for all construction.

The Contractor shall furnish the Owner/Inspector, within thirty (30) days after receipt of Notice to Proceed, a quality control plan which shall include the procedures, instructions and reports to be used. This document will include as a minimum:

1) The Quality Control Organization;

2) Authority and Responsibilities of Quality Control Personnel;

3) Methods of Quality Control, including that for his subcontractor's work;

4) Method of Documenting Quality Control Operation, and Inspection.

Authority and Duty of the Inspector

The Inspector employed by the Owner is stationed on the work to:

1) Keep the Owner informed as to the progress of the work and the manner in which it is being performed.

2) Report whenever it appears that the materials furnished and the work performed by the Contractor fail to fulfill the requirements of the Specifications and Contract.

3) Call to the attention of the Contractor any deviation from or infringements upon the Plans and Specifications.

4) Check and verify that the Contractor is keeping and maintaining Project As-Built Drawings.

Inspectors shall be authorized to inspect all WORK done and materials furnished and to exercise such additional authority as may be delegated to them in writing by the Engineer. Such inspection may extend to all or any part of WORK done and material furnished. They shall have authority to reject defective material and to suspend any WORK that is being done improperly, subject to the final decisions of the Engineer.

Such inspection shall not relieve the Contractor from any obligation to furnish acceptable materials or to perform all WORK strictly in accordance with the requirements of the Plans and Specifications.

Resident Project Inspectors shall not be authorized to revoke, alter, enlarge, relax, or release any requirements of the Specifications, nor to approve or accept any portion of the WORK, nor to issue instructions contrary to the Plans and Specifications. They shall, in no case act as foremen or perform other duties for the Contractor nor interfere with the management of the WORK by the latter. Any advice which Inspectors may give the Contractor shall in no way be construed as binding the Engineer or the Owner in any way, or releasing the Contractor from the fulfillment of the terms of the Contract.

The Owner, the Engineer, and his authorized Inspectors will at all times have access to the WORK, to determine if the WORK is proceeding in accordance with the CONTRACT DOCUMENTS. If in the opinion of the Owner, the Engineer and his authorized Inspectors, the WORK is not proceeding in accordance with the CONTRACT DOCUMENTS, or the Contractor is utilizing undesirable construction practices, the Owner, the Engineer and/or through his authorized representatives, may direct the Contractor to cease WORK and correct all DEFECTIVE WORK and undesirable construction practices. The Contractor will bear all expenses for correcting DEFECTIVE WORK, and will bear any and all monetary losses and expenses relating to and resulting from ceasing of WORK because of DEFECTIVE WORK. Such expenses to also include compensation to the Owner for non-productive inspection expenses during the time lost while corrective DEFECTIVE

WORK, the Contractor will not be granted an extension of the Project scheduled completion time.

General Inspection of Materials and Workmanship

All materials used in the construction of the Project shall be subject to adequate inspection in accordance with generally accepted standards, as required and defined in these CONTRACT DOCUMENTS.

The Contractor shall provide at the Contractor's expense the inspection services required by the CONTRACT DOCUMENTS.

If the CONTRACT DOCUMENTS, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any WORK to specifically be inspected, testing, or approved by someone other than the Contractor, the Contractor will give the Owner timely notice of readiness. The Contractor will then furnish the Owner the required certificates of inspection, testing or approval.

Inspections, tests, or approvals by the Owner or others shall not relieve the Contractor from the obligations to perform the WORK in accordance with the requirements of the CONTRACT DOCUMENTS.

The Owner and the Owner's representatives will at all times have access to the WORK. In addition, authorized representatives and agents of any participating Federal or State agency shall be permitted to inspect all WORK, materials, payrolls, records or personnel, invoices of materials, and other relevant data and records. The Contractor will provide proper facilities for such access and observation of the WORK and also for any inspection or testing thereof.

If any WORK is covered contrary to the written instructions of the Engineer it must, if requested by the Engineer, be uncovered for the Engineer's observation and replaced at the Contractor's expense.

If the Engineer considers it necessary or advisable that covered WORK be inspected by others, the Contractor, at the Engineer's request, will uncover, expose or otherwise make available for observation, inspection or testing as the Engineer may require, that portion of the WORK in question, furnishing all necessary labor, materials, tool and equipment. If it is found that such WORK is defective, the Contractor will bear all the expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction, if, however, such WORK is not found to be defective, the Contractor will be allowed an increase in the Contract price or an extension of the Contract time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing and reconstruction and an appropriate CHANGE ORDER shall be issued.

Substitutions

Whenever a material, article, or piece of equipment is identified on the Drawings or Specifications by reference to brand name or catalog numbers, it shall be understood that this is referenced for the purpose of defining the performance or

other salient requirements and that other products of equal capacities, quality and function shall be considered. The Contractor may recommend the substitution of a material, article, or piece of equipment of equal substance and function for those referred to in the CONTRACT DOCUMENTS by reference to brand name or catalog number, and if, in the opinion of the Engineer, such material, article, or piece of equipment is of equal substance and function to that specified, the Engineer may approve its substitution and use by the Contractor. Any cost differential shall be deductible from the Contract Price and the CONTRACT DOCUMENTS shall be appropriately modified by CHANGE ORDER. The Contractor warrants that if substitutes are approved, no major changes in the function or general design of the Project will result. Incidental changes or extra component parts required to accommodate the substitute will be made by the Contractor without a change in the Contract Price or Contract Time.

2b. Items of Work to be Inspected

Because the Contract is on a unit price basis the Inspector shall need to maintain records of the quantities of all materials used in the project.

Although the Superintendent of West Boggs Park will be responsible for lowering the lake pool level to below the construction site elevations, the Contractor will be responsible for ensuring adequate dewatering of the sites during construction.

All road surfaces used for equipment and machinery access shall be restored to original condition.

The Owner's representative Inspector shall ensure Contractor compliance with his Quality Control Plan as submitted.

Area 1

The items of work to be inspected include the following items:

Shot Rock Pile

- Height of the dumped shot rock in the channel.
- Layout of shot rock on either side of the flow diversion shot rock in-channel.

Steel Sheet Piling Weir

- Layout of steel sheet piling weir.
- Ensuring sheets are driven straight and plumb.
- Ensuring sheets are driven with the proper five degree (5°) of swing where the piling is to be installed in an arc.
- Confirming sheets are driven to correct height.
- Location and dimensions of stop log openings.
- All welds shall be visually inspected.

Stop Log Outlet Openings

- Correct installation of H-piles for stop log openings including:
    - correct width between H-Piles.
    - plumb and straight installation of H-Piles.
    - correct installation of welded angles to H-piles for bracketing stop logs.
    - all seam welds are to be inspected for quality.
    - sheet piling and steel plates beneath the stop logs should be inspected for water tight seal so that water is not passed below stop logs.

Stop Logs

- Stop log material is to be inspected for quality.
    - no knots in softer woods such as western cedar.
    - western cedar is to be No.1 or structural select.
    - no lateral splits in the stop log material.
    - material should be straight with no bowing.
    - material should be a wood recognized as having long life in underwater applications.
        - Chromated, Copper, Arsenate (CCA) treated wood is not to be used.

Erosion Control

- Geofabric is to be installed throughout the entire area within the steel sheeting weir.
- Shot rock or at least 12 inch rip-rap is to placed throughout the bottom of the area within the steel sheet piling weir, evenly covering the geofabric.
- The rip-rap within the weir, behind the stop log openings shall be grouted for two feet beyond either side of the stop log opening, for a distance of six feet from the sheeting into the weir area.
- Bank revetment along the road within the weir structure and for ten feet beyond the intersection of the sheet piling with the road bed (outside the weir) shall have the specified geofabric and rip-rap installed.

Area 2

The work to be inspected include the following items:

Shot Rock Pile

- Height of the dumped shot rock in the channel.
- Layout of shot rock on either side of the flow diversion shot rock in-channel.

Steel Sheet Piling Weir

- Layout of steel sheet piling weir.
- Ensuring sheets are driven straight and plumb.
- Confirming sheets are driven to correct height.
- Location of stop log openings.

Stop Log Outlet Openings

- Correct installation of H-piles for stop log openings including:
    - correct width between H-Piles.
    - plumb and straight installation of H-Piles.
    - correct installation of welded angles to H-piles for bracketing stop logs.
    - all seam welds are to be inspected for quality.
    - sheet piling and steel plates beneath the stop logs should be inspected for water tight seal so that water is not passed below stop logs.

Stop Logs

- Stop log material is to be inspected for quality.
    - no knots in softer woods such as western cedar.
    - western cedar is to be No.1 or structural select.
    - no lateral splits in the stop log material.
    - material should be straight with no bowing.
    - material should be a wood recognized as having long life in underwater applications.
        - Chromated, Copper, Arsenate (CCA) treated wood is not to be used.

Erosion Control

- Geofabric is to be installed beneath all rip-rap applications.
- Shot rock or at least 12 inch rip-rap is to placed downstream of each stop log opening evenly covering the geofabric.
- The rip-rap behind the stop log openings shall extend for six feet beyond either side of the stop log opening, for a distance of ten feet from the sheeting downstream of the weir.
- Bank revetment on either end of the weir structure to continue at least two vertical feet above the top of the last sheet pile member.

- The rip-rap and fabric should also extend for ten (10) feet upstream and downstream of the intersection of the sheet piling with the slope at each end and continue up the slopes to an elevation of at least 507 feet.

2c. Inspector Layout and Staking

The on-site inspector is not responsible for the correct layoiut and staking of the project. This is the responsibility of the contractor, however, the following information is provided to the inspector for guidance and advice in the event the contractor should need it.

Area 1 Shot Rock Pile

The site in Area 1 designated on the plans to have shot rock dumped into it must be laid out in the proper location. The horizontal location can be laid out in the field from measurements pulled from the existing C.R. 600 North. The horizontal plane distances can be scaled from the topographic map provided in the plans.

Horizontal Layout of In-Channel Shot Rock

The (north-south) centerline of the shot rock pile within the Area 1 channel can be located by measuring 310 feet east from the western edge of the new bridge structure platform (on C.R. 600 N.) as illustrated on the topographic map supplied in the plans.

The north edge (right bank looking upstream) of the creek channel is approximately 160 feet south of the south edge of C.R. 600 North, and the south channel edge (or left bank) is approximately 172 feet south of the south edge of C.R. 600 North.

The shot rock is to be distributed evenly across the channel from bank to bank to an average height from 500.5 to 501.5 feet above MSL. The upstream-downstream width of the dumped shot rock within the channel should be at least eight (8) feet wide.

Horizontal Layout of Streambank Revetment

The streambank revetment (at the location of the shot rock dumped in the channel) shot rock is to be laid from the edges of the channel to, at least, fifteen (15) feet beyond each side of the channel to prevent erosion of the streambanks by water trying to go around the dumped shot rock.

The upstream-downstream width of the revetment shall extend at least twelve (12) feet upstream and twelve (12) feet downstream of the centerline of the piled shot rock.

Vertical Layout of Shot Rock Pile

Given the size and shape of the shot rock, the average height of the shot rock within the channel proper is to be between 500.5 and 501.5 feet above MSL. This elevation is tied to either the temporary bench mark (TBM) located along C.R. 600N or the TBM on top of the center of pipe arch along St. Mary's Road as illustrated in the plans.

Area 1 Steel Sheet Piling Weir

The site in Area 1 designated on the plans to have a steel sheeting weir, with associated rip-rap, that must be laid out in the proper location. The horizontal and vertical location can be laid out in the field from measurements pulled from the top of the existing 13.5' x 8.5', corrugated, galvanized pipe arch beneath St. Mary's Road.

Horizontal Layout of Steel Sheeting Weir and Revetment

The sides of the weir that run perpendicular to the St. Mary's Road bed (east-west) should each be twenty (20) feet from the center line of the existing pipe arch.

The sides of the weir driven to 502.5' elevation are to extend from the road bed out to eleven (11) feet past the opening of the existing pipe arch.

The stop plank structures are to be installed at the end of the 502.5' piling. Beyond the stop log structures, the 62 foot radius of steel sheeting shall begin.

Bank revetment on the existing road side slope, utilizing geofabric and rip-rap, will extend for ten (10) feet either side of the outside of the steel sheeting.

Vertical Layout of Steel Sheet Piling Weir

The top of the steel sheeting wall shall be set in relation to the established temporary bench mark set at the top of the existing pipe arch as noted on the plans.

Area 2 Shot Rock Pile

The site in Area 2 designated on the plans to have shot rock dumped into it must be laid out in the proper location. The horizontal location can be laid out in the field from measurements pulled from the existing gravel access road immediately north of the Shurn Creek Tributary. The horizontal plane distances can be scaled from the topographic map provided in the plans. Vertical elevations can be derived from temporary bench marks set by Accu-Air Surveys as indicated on the plans.

Horizontal Layout of In-Channel Shot Rock

The centerline of the shot rock pile is to be installed perpendicular to the flow of Shurn Creek. The location in the channel to dump the shot rock can be located by measuring 62 feet east from the culvert (see plans for location of culvert) in the

gravel access road to the centerline of the road and the due south 375 feet to the centerline of the Shurn Creek Channel as illustrated on the topographic map supplied in the plans.

The north bank (right bank looking upstream) of the creek channel is approximately 355 feet south of the south edge of the gravel access road, and the south channel edge (or left bank) is approximately 386 feet south of the south edge of the gravel road.

The shot rock is to be distributed evenly across the channel from bank to bank to an average height from 500.5 to 501 feet above MSL. The upstream-downstream width of the dumped shot rock within the channel should be at least eight (8) feet wide.

Horizontal Layout of Streambank Revetment

The streambank revetment (at the location of the shot rock dumped in the channel) shot rock is to be laid from the edges of the channel to, at least, fifteen (15) feet beyond each side of the channel to prevent erosion of the streambanks by water trying to go around the dumped shot rock.

The upstream-downstream width of the revetment shall extend at least twelve (12) feet upstream and twelve (12) feet downstream of the centerline of the piled shot rock.

Vertical Layout of Shot Rock Pile

Given the size and shape of the shot rock, the average height of the shot rock within the channel proper is to be between 500.5 and 501 feet above MSL. This elevation is tied to the benchmark indicated on the plans to be 950 feet north of the top of the Shurn Creek culvert, on the west side of C. R. 1050 E. The Benchmark is a baby railroad spike nailed to the side of a utility pole on the west side of C.R. 1050 E., as indicated on the plans.

Area 2 Steel Sheet Piling Weir

The site in Area 2 designated on the plans to have a steel sheeting weir, with associated rip-rap, that must be laid out in the proper location.

Horizontal Layout of Steel Sheeting Weir and Revetment

The horizontal location can be scaled from the site plan provided in the plan set. The steel sheeting wall must be installed running north and south in the place indicated on the plans.

The sheet piling weir can be laid out by continuing the fence line, on the east side of the Wickman access road, on north. The steel sheet piling weir shall run parallel to this fence line at 92 feet west of the fence line, as depicted on the Plans. Stop log outlet structures shall be installed in the locations indicated on the plans.

Vertical Layout of Steel Sheet Piling Weir

The top of the steel sheeting wall shall be set in relation to the established temporary bench mark set by Accu-Air Surveys on the utility pole along C.R. 1050 E. as indicated on the plans.

Layout of Rip-Rap Associated with the Sheet piling Weir

Geofabric and rip rap of 12 inches or larger shall be hand laid at each end of the steel sheeting wall at least ten (10) feet upstream and downstream of the steel weir, and continue up the slope of each end a additional two feet higher than the sheet piling wall to 507 feet.

Rip-rap at least 12 inches in diameter or shot rock shall be placed on the downstream side of the stop plank outlet structures as indicated on the plans.

2d. Contractor's Maintenance and Development of As Built Drawing

While it is the responsibility of the Contractor to develop and maintain As-Built drawings for each phase of construction, the on-site inspector is required to maintain copies in clear readable order on the project site for the inspection by any interested party.

The Contractor shall keep one (1) copy of all project specifications, plans, addenda, modifications, supplemental drawings, shop drawings and change orders at the project site in good order and annotated to show all changes made during the construction process. In addition, the Contractor and Inspector shall keep one (1) set of "As-Built Drawings" for the project.

These as-built drawings will show all final elevations, all final dimensions, sizes and depths for buried sheets, members, structures, and all other information as necessary to constitute as-built records. These documents shall be kept daily by the Contractor and be made available to the Inspector and routinely checked by the Inspector for completeness and accuracy based on the Inspector's daily records and notes. It will be the Contractor's responsibility to furnish any and all information lost due to the Inspector's loss of these record drawings and vis-a-vis. In addition to other Contract requirements, retainage will be partially based on the Contractor's and Inspector's ability to maintain good as-built records, as determined by the Owner. Upon completion of the project these record "as-built" drawings together with any other annotated supplemental plans, drawings, sketches, etc. shall be delivered to the Owner for his final review and approval. If approved, the documents will be delivered to the Engineer for the Owner's record. If disapproved, they will be returned to the Contractor for corrections, as necessary.

2e. List of Inspector's Equipment

All persons providing construction inspection services shall have available at all times the following minimum list of equipment:

- A surveying level, tripod, and measurement rod in good working condition.
- Fiberglass or steel measuring tapes.
- Device for determining the 5° angle swing required in each sheet driven in the Area 1 semi-circle weir.
- Note/journal keeping materials and hand calculator.
- A four foot level/plumb rule in good operating condition.
- Materials to develop and maintain As-Built Drawings.

2f. Required Qualifications of Inspectors

All persons performing inspection services shall have the following minimum qualifications:

- Demonstrated expertise/documented experience in the establishment of vertical and horizontal control.
- Experience in the inspection and/or fabrication of welded steel joints.
- Experience in the inspection and/or installation of geofabric and rip-rap for erosion control.
- Experience in the identification and inspection of wood and timber products applied in lateral stress applications.
- Knowledge and experience in the application of concrete used for grouting hand laid rip-rap.

3. OPERATIONS AND MAINTENANCE PLAN

3a. Description of Maintenance Work to be Performed

The following report comprises the Engineer's suggested methods, strategies, and timing of operating and maintaining the hydraulic control structures designed for the "T By 2000" lake enhancement design project. The sediment control structures have been designed to require a minimum of operator attention, provide operator safety, and minimize long term maintenance attention and cost.

The maintenance to be performed is primarily the periodic removal of accumulated sediment from the sedimentation basins. If the Park Board decides to have the basins dredged with land based earth moving equipment then the basins will have to be dewatered.

Following is a description of the tasks anticipated to properly operate and maintain the sediment control structures so they provide long term service operating at peak efficiency.

- Water level control with stop logs.
- Periodic removal of sediment from basins.
- Periodic removal of stop logs and dewatering of basins.
- Inspection and/or replacement of stop logs.
- Inspection of rip-rap and erosion control measures.

Water Level Control

Generally accepted methods of hydraulic modeling have been employed in the design of the sedimentation basins. While it is not expected that the water level will have to be adjusted in the basins, the actual elevations of the water levels in various rain events may be slightly different than what the hydraulic modeling proved. Also, conditions in the watershed tend to change through either natural or manmade causes which increase the rate of runoff and, correspondingly, the elevation of the water surface in given storm events. If the water level is frequently too high, flooding out adjacent property owners, the structures are designed to have stop planks removed for water level control.

To remove the stop logs, the operator must first remove the padlocked angle iron from above the planks. The Engineer recommends only one plank be removed from each outlet at a time and the new water level allowed to equilibrate prior to removing additional planks.

3b. Projected Maintenance Cycle

Periodic Removal of Stop Logs and Dewatering of Basins

Even if the sediment removal is to be done using a hydraulic dredge, it is good practice to draw down lake levels in winter to expose lake sediments to the atmosphere. This oxidizes the sediments, in an ordinarily reduced environment, enhancing the bonding of nutrients to the sediment particles.

To completely dewater the basins the operator must remove the stop logs in the outlet structures. This should be done after the water level of the main body of the Lake has been lowered to an elevation of less than 494 feet. The operator can then access the downstream side of the stop log outlet structures while standing on the rip-rap.

Given the nature of steel sheet piling (which is not watertight), the water level upstream of the structures, should fall as the main lake is lowered since the water is able to pass through the interlocks of the steel sheeting wall. Therefore, it may be unnecessary for the operator to remove the stop planks to dewater the basins.

It is recommended that the operator be equipped with the following equipment:

- chest waders
- rain coat
- two (2) flat pry bars
- claw hammer at least 20 ounces

The recommended way to remove the individual stop logs is by the use of a flat pry bar and hammer to pry up each individual plank. Only one or two planks with water behind them should be removed at one time. After a plank has been removed from an opening, the operator should move to another opening to remove one or two planks. After one or two planks are removed from each opening in a structure the operator should allow the water level to equilibrate at that basin prior to removing additional planks.

If the planks cannot be easily removed using pry bars and a hammer, the Operator has the option of using a chain saw to remove the planks. This is the purpose of specifying wood stop planks rather than a synthetic material.

Inspection and/or Replacement of Stop Logs

While the basins are dewatered the Operator should inspect the stop planks and replace them as the Operator deems necessary.

Inspection of Rip-rap and Erosion Control Measures

All exposed rip-rap should be inspected for stability on an annual basis. Any rip-rap that is misplaced or that has been moved should be replaced.

When the basins are temporarily dewatered, all rip-rap erosion control measures should be inspected and where stones have been moved they should be replaced with heavier stones. Where erosion has occurred, protective measures should be installed to protect from further erosion.

3c. Periodic Removal of Sediment from Basins

Timing of Periodic Maintenance

The USDA Soil Conservation Service (SCS) recommends that sedimentation basins have the trapped sediment removed when the basin has lost 50% of its design volume.

The Engineer's suggested timing of periodic maintenance is based on the use of widely accepted, statistical modeling calculations of when the sediment control basins will lose half of their designed volume to trapped sediments. These models were developed by the SCS based on empirical data from experimental sedimentation basins in situations similar to those found in this watershed.

The calculations used for modeling the trapping efficiency and rate of basin infilling are from the National Engineering Handbook, Section 3, Sedimentation.

Some quantitative assumptions on variable conditions in the subject watersheds had to be made to provide values to plug into the models. The assumptions used in the sedimentation rate calculations are as follows:

Area 1

Parameter	Value*	Source
Crop Land Soil Loss	7 tons/acre/year	Daviess Co. SWCD
Acres Cropped Land	900 Acres	Daviess Co. SWCD
Soil Loss Other Uses	5 tons/acre/year	Daviess Co. SWCD
Acres Other Land Uses	276 Acres	Daviess Co. SWCD
Sediment Yield Coefficient	.55	SCS Area Office
Sediment Yield to Basin	4,224 tons/year	CEI Calculation
Storage Volume of Basin	47 acre feet	TR-20
Sediment Density	65 lbs/ft^3	NEH-3
Annual Sediment Load	3 acre feet/year	Daviess Co. SWCD
Initial Volume of Basin	47 acre feet	TR-20
Trapping Efficiency of Basin	85%	NEH-3 Figure 8-2
Annual Sediment Entrapment	2.55 acre feet/year	CEI Calculation
No. of Years to Fill Basin 50%	9 Years	CEI Calculation
Annual Sediment Accumulation	3,548 tons/year	CEI Calculation

Area 2

Parameter	Value*	Source
Crop Land Soil Loss	7 tons/acre/year	Daviess Co. SWCD
Acres Cropped Land	1,527 Acres	DAviess Co. SWCD
Soil Loss Other Uses	5 tons/acre/year	Daviess Co. SWCD
Acres Other Land Uses	565 Acres	Daviess Co. SWCD
Sediment Yield Coefficient	.55	SCS Area Office
Sediment Yield to Basin	7,433 tons/year	CEI Calculation
Sediment Density	65 lbs./ft^3	NEH-3
Annual Sediment Load	5.25 acre feet/year	Daviess Co. SWCD
Initial Basin Volume	64.2 acre feet	TR-20
Trapping Efficiency of Basin	85%	NEH-3 Figure 8-2
Annual Sediment Entrapment	4.46 acre feet	CEI Calculation
No. of Years to Fill Basin 50%	7 Years	CEI Calculation
Annual Sediment Accumulation	6,318 tons/year	CEI Calculation

The Area 1 basin is projected to be 50 percent filled with sediment in eight (8) years and the Area 2 basin is projected to be 50 percent filled in seven (7) years. This allows for the staggering of maintenance work.

* All values represent existing conditions. Although soil loss values are expected to decrease with implementation of watershed land treatment.

As noted above the in-basin sedimentation rate and subsequent timing of periodic maintenance, has been calculated using values from existing conditions. Although soil loss rates are expected to decrease, due to improved land treatment in the watershed, the existing condition values have been used for projections for the following reasons:

1) Even after land treatment measures are in place, it will take several years for the stream systems to flush the transitory sediments stored in the steam beds. To estimate the time required for the incoming stream systems to reach a new equilibrium with their watersheds are far beyond the scope of this project.

2) Using existing conditions a conservative "worst expected case" condition. This allows the Owner to plan manpower and budget conservatively.

The actual time it takes for the basins to become 50% percent full of sediment may be slightly different. However, for project planning and budgeting purposes

it is recommended that the Park Board use the Engineer's projected periodic maintenance schedule.

It is recommended that when the basins are dredged, as much sediment as possible be removed to increase the volume, thus trapping efficiency, of the basins.

Spatial Distribution of Sediments

The Soil Conservation Service, through empirical evidence, has determined that in impounded water reservoirs, with watersheds of low to moderate relief in which the incoming sediments consist of fine silty and clayey soils, sheet flow is the principle eroding agent with sediment carried in suspension rather than being scraped along the incoming channel beds.

West Boggs Lake and the proposed constructed sedimentation basins have these characteristics. In these systems, only ten (10) percent of the incoming sediment load will be deposited above the elevation of the control structures. The remaining 90 percent will be deposited in the basin proper.

This means that in Area 1 ten percent of the incoming sediment will be deposited above the 502' elevation and may be reachable from C.R. 600 N with land based excavating equipment, such as a Gradall, without draining the lake.

In Area 2, ten (10) percent of the incoming sediment will be deposited above the 501.3 feet elevation. This sediment may also be reachable via land based equipment in the western end of Park Board property without draining the main body of the lake.

The remaining sediments must either be removed using hydraulic dredging equipment or through dewatering and removal with land based earth moving equipment.

3d. Maintenance Strategies and Contracting

Sediment Removal Methods

There are three main methods of sediment removal, hydraulic dredging, drag-line dredging, and land based excavating with earth moving equipment. Any of which will remove the sediment. The Engineer suggests that the Owner solicit bids from qualified contractors to perform the sediment removal and let cost dictate which is the most efficient method to use. Have the contractor submit a Plan of Operation, detailing the specifics of their proposed operation, with their bid to perform the sediment removal and disposal.

Each method has a variety of advantages and disadvantages to consider. These advantages are outlined in the following discussion.

Hydraulic Dredging

Hydraulic dredging uses a floating platform with a horizontal cutter-head and pump are best for cutting soft flocculent lake bottom sediments to cut the lake bottom and pump a slurry to a dewatering or disposal site.

Advantages

Advantages to hydraulic dredging include the following:

- The maintenance dredging can be done any time of year since lake dewatering is not required.
- It is generally cheaper since there is typically fewer machines and personnel on the project site.
- Does not require heavy vehicular traffic for removal of spoil.
- Small portable equipment is relatively common.
- Relatively maneuverable.

Disadvantages

- Difficult to access smaller waters without developing launch facilities.
- Slower than land based machinery.
- Resuspension of fine sediments into the water column and associated liberation of nutrients from sediment particles.
- Pumping rate must be balanced with inflow to the lake to prevent excessive drawdown of the water level.
- Temporary, localized destruction of benthic habitat and food chain.
- The disposal site must be adequately sized to facilitate settling rates even after considerable sediment has been pumped into the basin. Disposal sites must be sized for end of project efficiency.
- The slow settling rates of sediments in a slurry dewatering pit or lagoon may drastically slow down the rate of pumping to the dewatering facility.
- A temporary NPDES permit may be required for a point source return flow pipe.

Drag-Line Dredging

Given the fact that West Boggs Lake is located in a coal mining area, large scale drag-line equipment is readily available.

Advantages

- May be relatively inexpensive due to regional availability.
- The size of drag-lines available in the region area are extremely large.
- Leaves rough uneven bottom for habitat variation.
- Spoil can be loaded from shore for off-site disposal.
- Can operate in relatively confined spaces.

Disadvantages

- Drag-lines, generally, tend to be relatively slow.
- Land based with a limited reach.
- Piles spoil up along shore in front for later transportation and disposal.
- Tends to not efficiently grab highly flocculent sediments.

Land Based Earth Moving Equipment

Land based removal of sediments involves draining the lake and allowing ample dewatering. Then excavating the sediments with low ground pressure (e.g., long track bulldozers) earth moving equipment, loading into dump trucks and disposing of the sediment off site.

Advantages

- Can move large quantities of material relatively quickly.
- Dredge spoil can be transported to different areas for beneficial reuse, such as topsoil.

Disadvantages

- Trucking and machinery costs to remove sediments from the project site may be high.
- Heavy truck traffic may cause damage to roads and bridges.
- Requires management of incoming water.

3e. Disposal of Dredge Spoil

Permitting for Dredging and Disposal of Spoil

The dredging operation will require a permit from the U.S. Army Corps of Engineers, since West Boggs Lake is considered to be "waters of the United States" under the Clean Water Act. This permit is required even when dredge spoil is disposed on an upland site.

Based on previous experience of CEI on similar projects in similar areas, It is not anticipated that a permit will be needed from the Indiana DEpartment of Environmental Management (IDEM) for land disposal of dredge spoil.

Most lake sediments in rural areas have relatively low concentrations of substances regulated as hazardous waste. Therefore, the material can be disposed of in almost any upland site without acquiring an IDEM permit.

Disposal of dredged material into the main body of West Boggs Lake is not considered a feasible option. Disposal into a wetland, navigable waterway, or other waters of the U.S. will require a permit from the U.S. Army Corps of Engineers.

The most frequently used method of disposal for hydraulically dredged sediments involves the construction of a temporary diked, basin, on an upland site, to pump the slurry to. The temporary basin has a sluice gate with a pipe to dewater the basin after the sediments have settled out of the water column. The dewatering outlet can either be a pipe delivering water back to the lake, or, the water can be discharged on the ground surface and allowed to drain back into the lake via overland flow. Overland return flow has two advantages over piped return flow:

1) Overland return flow allowed to drain over vegetated land is further filtered of sediments prior to its discharge back into the Lake.

2) The discharge of return flows from a point source (pipe outfall) may require a temporary NPDES permit to discharge from the IDEM. There could be strict suspended solids limits in such a permit that would require more expensive treatment of the return water. This could involve either: applying a flocculent to the basin to precipitate (coagulate and settle) sediments from the basin water column; or, sizing the basin and timing the operation of the dredge such that the water is allowed longer residence time in the basin for increased sediment fallout. Increased basin sizing could make a temporary basin difficult to site and require a much longer pumping distance.

Disposal of Dredge Spoils

Once dredge equipment has been selected for the project, disposal sites must be identified. If hydraulic dredging is to be performed a dewatering/disposal site must be designed with the appropriate size, containment and outlet structures. Preferably sediments should be disposed outside the watershed, or at least in an application protected from erosion and transport back into the lake.

Careful consideration must be given to disposal of excavated materials to minimize costs. An upland site is preferred. Disposal of hydraulically dredged material requires a dewatering and disposal site such as construction of a temporary basin(s), a dry pond or a water and sediment control basin (WASCOB). Disposal sites should be rotated, if possible to minimize the wear and tear on roads, if trucked, or to allow adequate retention time if pumped.

There is a potential disposal site available on Park Board property in each Area 1 and Area 2. These are illustrated on the following map.

CEI staff contacted the Daviess County Highway Department to find out where they dispose of sediments from ditch maintenance. Highway department personnel claim they usually have local landowners requesting the material be dumped on their property.

The West Boggs Park Superintendent also has disposal sites available on Park property. However, the Park proper is a long haul distance from the basins. It may save the Park Board money to arrange disposal sites on private property, giving consideration to weight limits of bridges, prior to the letting of the maintenance contracts.

It is anticipated that the dewatered material removed from the lake will be in high demand locally as topsoil or a soil amendment by persons capable of self hauling.

The disposal of dredged material can account for half of the total cost of sediment removal operations. If the owner wishes the dredge spoil can be left piled at an accessible site available to self-haulers for a giveaway program. Otherwise it can be specified in contract documents that the contractor is responsible for removal and disposal of all spoil.

3f. Estimated O & M Costs per Year

Comparing costs are very difficult because of the highly variable disposal conditions with each method. For example the cost of siting and constructing a dewatering facility for hydraulically dredged sediments plus any cost in removing the material after dewatering (if a give away program is not implemented) may be more or less expensive than loading, transporting, and disposing of sediments dredged via earth moving equipment or drag-lining. These costs are highly variable from Contractor to Contractor.

The Engineer recommends the owner advertise for bids from qualified, responsible contractors without specifying the precise type of equipment to be used. The bid documents may specify that the contractor is responsible for obtaining disposal sites and arranging the timing and operation of the sediment removal to not disrupt the normal operation of the Park and Lake during the high use season. For example, if the operation requires dewatering this should be done after labor day, but if sediments must be trucked from the site the Highway Department may require the contractor to wait until after the third week of April when the roads are more capable of supporting the loads.

It is recommended that the Park Board retain an engineer/consultant to obtain permits, and to develop the contract documents and specifications for the sediment removal operation.

The following table of estimated costs was generated using actual and average costs from the following sources:

- Indiana Department of Transportation, 1993 tabulation of lump sum and unit prices from road contracts;
- The EPA Lake and Reservoir Restoration Guidance Manual;
- Means Site Work Cost Data;
- Commonwealth Engineers lagoon cleaning project information.

Area 1

Activity	Cost/Unit*	No. of Units	Total
Stop Log Replacement	$10 / Plank	15 estimated	$150.00
Hydraulic Dredge Mobilization	$2,100	1	$2,100.00
Earth Moving Equipment Mobilization	$2,200	1	$2,200.00
Sediment Removal - Hydraulic	$2.30 / yd^3	32,315	$74,325.00
Sediment Removal - Earth Moving	$2.65 / yd^3	32,315	$85,635.00
Transportation and Disposal (loader and 2 mile round trip)	$3.15 / yd^3	32,315	$101,792.00

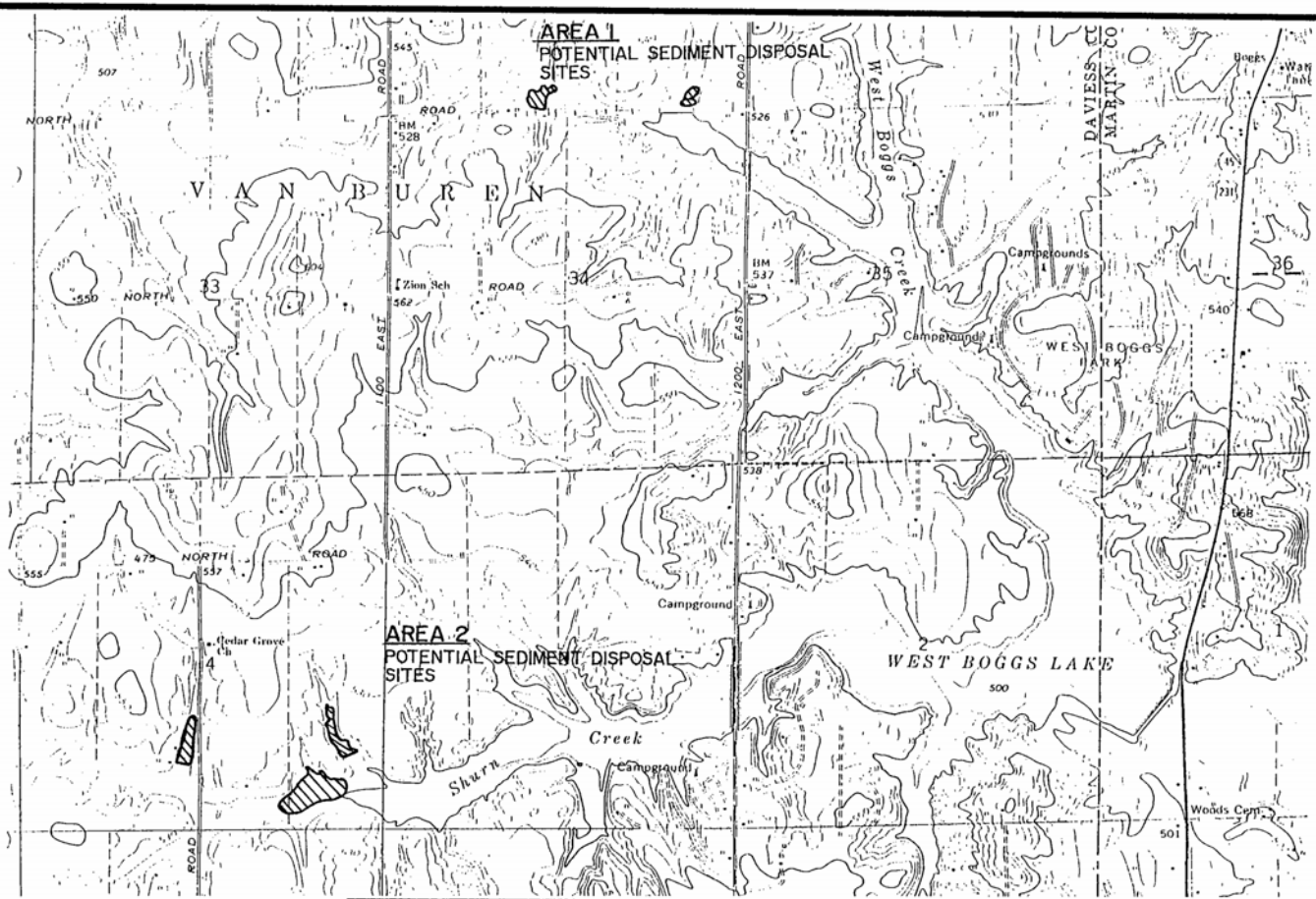
Area 2

Activity	Cost/Unit*	No. of Units	Total
Stop Log Replacement	$10 / Plank	45 (estimated)	$450.00
Mobilization - Hydraulic Dredge	2,100	1	$2,100.00
Mobilization - Earth Moving	2,200	1	$2,200.00
Sediment Removal - Hydraulic	$2.30 / yd^3	44,140	$101,522.00
Sediment Removal - Earth Moving	$2.65 / yd^3	44,140	$116,971.00
Transportation and Disposal (loader and 2 mile round trip)	$3.15 / yd^3	44,140	$139,041.00

* Sources of Cost Averages:
-- INDOT Catalog of Unit Price Averages
-- Means Site Work Cost Data
-- Commonwealth Engineers Lagoon Cleaning Projects
-- EPA Lake and Reservoir Restoration Guidance Manual

The estimated cost range for Area 1 maintenance is from $76,575 to $189,777, depending on the type of equipment used and whether the dredge spoil is hauled away and, if so, how far. If the basin is dredged every nine (9) years, the cost ranges from $8,508 to $21,086 per year, in 1993 dollars.

The estimated cost range for Area 2 maintenance is from $104,072 to $258,662, depending on the same variables mentioned for Area 1 above. If the basin is dredged every seven (7) years, the cost ranges from $14,867 to $39,952 per year, in 1993 dollars.



COMMONWEALTH ENGINEERS, INC.

POTENTIAL SITES FOR MAINTENANCE DREDGING
SEDIMENT DISPOSAL FOR AREAS I AND 2

4. POST CONSTRUCTION MONITORING PLAN

Two approaches can, and should, be taken to the monitoring component of the West Boggs Lake enhancement project.

1) Postmonitoring of overall lake water quality response.

2) Monitoring the effectiveness of a specific management practice, such as the constructed wetlands.

The 1988 EPA Lake and Reservoir Restoration Guidance Manual has a section on postmonitoring of lake restoration projects. It is suitable for monitoring overall lake water quality improvement resulting from implementation of restoration practices. The Guidance Manual contains a table listing a sampling protocol for overall lake monitoring.

The lake monitoring plan that follows will primarily focus on monitoring the effectiveness of the constructed wetlands projects at removing sediments and the limiting nutrient in aquatic systems phosphorus. A secondary component of the monitoring plan is to inspect structures and monitor the succession of the wetland system.

A plan to monitor the success of lake enhancement projects must contain four key elements:

1) Qualified personnel to perform the monitoring;

2) Clearly defined monitoring objectives with a specific set of monitoring parameters;

3) A monitoring schedule;

4) A reporting format.

4a Qualified Personnel

Personnel monitoring the success of the wetlands after construction is complete should have the following qualifications:

- General knowledge of wetland ecosystem functional values.
- Familiarity with the design objectives to be achieved by the constructed wetlands.
- Familiarity with identification of aquatic macrophytes (vegetation other than algaes), herbaceous vegetation, shrubs and trees.
- General familiarity with the watershed and soil types.

Persons qualified to perform part or all of the monitoring may include:

- Professional environmental scientists such as Commonwealth Biomonitoring staff.
- Daviess County SWCD staff.
- Bob Smolik, the current West Boggs Park Superintendent, who is trained as a forester.

4b Monitoring Objectives and Recommended Inspection Parameters

The objective of this monitoring program is to ensure that the wetlands are performing the water quality enhancement functions they were designed to provide. In order to monitor the effectiveness of constructed wetlands, a set of monitoring parameters must be defined. The following parameters should be monitored.

1) Vegetation community in each wetland basin:

- identification of the following plant classifications
  - submergents aquatic macrophytes
  - emergent macrophytes
  - herbaceous cover
  - shrubs (woody plants less than 4" diameter)
  - trees
- The areal cover of the identified vegetation should be recorded as illustrations on a diagram form of the constructed wetland basins.

Growth of dominant vegetation should be well established by July. A good monitoring program would include the identification and areal quantification of aquatic macrophytes. In the first few years of the life of the constructed wetlands it is expected that algaes will be a dominant plant. After the aquatic vegetation community is better established, the rooted macrophytes are expected to out-compete the algal community and nutrients will become tied up in macrophyte growth. As the constructed wetland ecosystems mature, a succession of the vegetation community is expected.

Both quantitative and qualitative success criteria must be developed to measure the success of the constructed wetland project. A site map from the engineering design phase of the constructed wetland project can be used as a base map for, monitoring the vegetative communities and the silt loading depth in the wetland basin. A photographic record is also a valuable monitoring tool for documenting the progression of the wetland ecosystem development.

2) Structural inspection:

- Human activity and vandalism, such as riding horses and off-road vehicles on embankments, destruction of outlet structures, herbicide applications, illegal firewood cutting, etc.
- Animal activity, such as groundhog, beaver or muskrat burrowing
- Erosive destabilization
- tampering with control and outlet structures
- erosive activities such as riding horses and off-road vehicles on embankments
- unauthorized harvest of trees for timber or firewood

Prompt reporting to Daviess County or conservation law enforcement personnel of any illegal activity impairing the performance or integrity of the constructed wetland systems

3. Chemical:

- Total Phosphorus (TP)
- Total Suspended Solids
- Transparency (Secchi depth) where possible.

Many other parameters are routinely measured in monitoring programs where ample funding and expertise are available. Most of these parameters are measured for reasons more academic than utilitarian. If information on additional parameters are deemed necessary, Commonwealth Biomonitoring is available to work with the Board to redefine monitoring objectives and professionally perform or supervise the monitoring activities.

4c Monitoring Schedule

The monitoring should be performed on a seasonal basis, with consideration given to interpreting the results of the chemical parameters. In different seasons, natural surface waters are expected to exhibit different chemical characteristics. This should be kept in mind when results are being analyzed. Therefore, results should not be compared between different seasons.

Chemical samples should be taken ahead of the constructed wetland and either from the effluent of the constructed wetland, the water held in the wetland near the dam or outlet structure, or in the main lake immediately downstream of the wetland systems. The sample should be taken from water representative of the average influent and either the average effluent or the well mixed water in the downstream portion of the constructed wetland.

Following is the recommended annual monitoring schedule and the parameters to monitor:

Table 1
Monitoring Schedule

Monitoring Parameter	Spring (April)	Summer (July)	Fall/Winter (Nov.-Feb.)
Vegetation Mapping		X	
Structural Inspection	X	X	X
Total Phosphorus	X	X	X
Total Suspended Solids	X	X	X
Secchi Depth	X	X	X

The objective of measuring transparency (Secchi depths) is for measuring the opaqueness due to suspended sediments as opposed to algal cells. It is expected that water coming into the constructed wetland will not have a high algal cell concentration. In the summer the algae community in the constructed wetland basins is expected to be fully blooming. At this time, due to algae density, the transparency in the effluent may be as low as the influent transparency.

The monitoring program should be implemented as soon as the constructed wetlands are filled to capacity and fully operational.

While the wetlands are expected to begin performing their intended purpose immediately, in-lake recycling of nutrients from main lake sediments will keep the phosphorus levels in the main lake water column high for several years to come.

4d Limitations to the Chosen Parameters

TSS and TP are the parameters most indicative of the functional success of the constructed wetlands.

Transparency (Secchi depth) can be affected by either dissolved organics or suspended solids. In the fall the concentration of dissolved organics are very high in surface waters due to the decomposition of vegetative matter. In the summer, algae blooms will limit transparency.

4e Sampling Locations and Sample Collection/Analysis

Water quality entering the wetlands should be compared to the water quality leaving the wetland. Therefore, on each monitoring occurrence, a sample should be retrieved from the runoff in the moving water.

Within 24 hours of the end of approximately a one-inch rain event, when sediment is being transported from the watershed into a constructed wetland basin, a Secchi depth reading should be taken in the channel at the point where the creek channel enters the wetland system.

A contract lab, such as Environmental Monitor Services in Indianapolis (phone 317-253-2439), can be used to perform the analytical chemistry services. The contract lab chosen for the analytical chemistry will typically supply sample containers for the collection and storage of water samples.

Water can be analyzed for TP and TSS at relatively reasonable rates. For example TP samples analyzed to detection limits of one tenth of a part per billion (.1ug/l) are usually performed for $28 per sample. Total Suspended Solids (TSS), measured in parts per million, can be analyzed at $14 per sample.

4f Reporting Format

The reporting of field measurements and observations should be done on standard forms made up by the person designated responsible for the monitoring and reporting of results. Care should be taken so that data from monitoring the constructed wetlands effectiveness can be used in a comparison to overall lake water quality postmonitoring results.

All field data sheets should be copied and stored in a three ring binder for annual compilation and analysis. Results of each monitoring should be tabulated so that comparisons between monitoring inspections are presented in only a few tables.

4g An Alternative Monitoring Approach

In the SCS National Engineering Field Handbook, Chapter 13 discusses the construction restoration, and enhancement of wetlands. Beginning on page 13-61 of this chapter is a section on monitoring constructed wetland systems. The protocol only differs from what has been suggested above in that, chemical sampling is not covered in the SCS handbook.

4h Anticipated Effects of the IDNR Fish Restocking Project

Because the IDNR Division of Fish and Wildlife will be drawing down the Lake in the winter of 1994 to perform a fish eradication and restocking program, in-lake monitoring in the following growing season may provide results not indicative of the effectiveness of the watershed land treatment/constructed wetland combination.

Removal of the carp in the IDNR fish eradication project in the winter of 1994 will tremendously improve water transparency in West Boggs Lake. Presently carp are likely the primary source of resuspension of sediments in the lake. This significantly limits the light penetration thus limiting the growth of aquatic vegetation.

4i Lake Drawdown Strategy

Timing of the drawdown can be helpful in flushing nutrients from the lake. In lakes that have an outlet structure capable of releasing water from the hypolimnion, occasional hypolimnetic releases during stratified periods can help remove soluble reactive phosphorus from the lake. It would be beneficial for West Boggs Park to release some water *prior to the fall turnover* through the lower gates. Care must be taken not to discharge too much anoxic water during this period to avoid a fish kill in West Boggs Creek downstream of the lake.

A possible release strategy would be to set the hypolimnetic discharge rate, from the lower gates, at a rate less than the rate of surface discharge over the spillway. This will allow oxygenated water to be released over the spillway along with the anoxic hypolimnetic water released though the lower gates, until the lake level is too low to pass over the spillway. Then as fall turnover occurs, the remaining water can be discharged.

Another release strategy would be to place rip-rap in the receiving stream to create oxygenating turbulence and pH adjustment as the hypolimnetic water is released from the lower gates.

During fall turnover, much of the debris and material laying on the bottom throughout the year becomes suspended. Draining the lake during this event would be strategic timing to help remove both dissolved phosphorus and organicly bound phosphorus temporarily suspended in the water column.

One strategy to use in the lake drawdown is to leave the water level down as long as possible. This will expose the lake bottom sediments to the atmosphere to oxidize the nutrient rich sediments causing the phosphorus to bind to sediment particles deeper in the substrate. In turn, this inhibits their release back to the water column when the lake is refilled.

The combination of implementation of watershed land treatment, constructed wetlands and the removal of carp, is expected to significantly increase water transparency. Determining which management strategy is responsible for the most improvement in the lake will be impossible since they will be performed concurrently.

As a result of increased transparency, depth of light penetration will increase significantly. With increased light penetration comes the development of an aquatic vegetation community. The soluble reactive nutrients will become tied up in vegetation and less available for measurement in the water column. The increased aquatic vegetation community will provide significantly improved gamefish and wildlife habitat.

5. DESIGN PROJECT REPORT

5a Introduction

General Background

West Boggs Lake is located 3 miles north of Loogootee Indiana. Impounded in 1971 through the federal Small Watershed Program, it was originally designed to have 622 acres of surface water, within the 7,870 acres of watershed. Due to erosion, from the primarily (68%) agricultural watershed, the lake has lost several surface acres now covering only 575 acres (a 7.6% loss of area). Correspondingly, considerable volume has also been lost over the years.

Due to sediment and nutrient loading from the watershed, the capacity of the lake to perform its beneficial functions is being reduced. Not as much water can be stored in storm events. Recreational opportunities are impaired due to water depth limitations, aquatic habitat siltation, and restricted light penetration limiting the growth of aquatic vegetation. The consequences of impaired recreational use to West Boggs Lake are a loss of recreational user revenue to the Daviess-Martin County area. In effect, the degradation of West Boggs Lake is not just an environmental problem, but social, political, and economic as well.

In an effort to address this sedimentation and water quality degradation, the Daviess-Martin County Joint Park and Recreation Board (Park Board), in conjunction with the Indiana Department of Natural Resources (IDNR), Division of Soil Conservation's "T By 2000" Lake and River Enhancement Program, sponsored a feasibility study to identify the sources and magnitude of sediment and nutrient inputs into West Boggs Lake. This study was also to examine the feasibility of alternative strategies to reduce and/or correct sediment and nutrient loading, appraise their cost/benefit effectiveness, and to prescribe the best alternative strategies for implementation by the Park Board and IDNR.

The feasibility study recommended watershed land treatment controls for the agricultural land uses, shoreline erosion control measures, sewage collection and treatment and the development of constructed wetlands at least in two tributary inlets contributing the greatest NPS pollutant load to the Lake.

The IDNR, Lake and River Enhancement Program emphasizes the "watershed approach" to reducing sediment and nutrient inputs to surface waters. Stabilizing sediments and sediment associated nutrients directly addresses the causes of cultural eutrophication. This is typically accomplished through Best Management Practices (BMPs) for land uses. When installed or performed on agricultural land these practices are typically referred to as land treatment measures. Keeping the soil where it belongs is the highest priority strategy.

Given the fact that well over 95% of the watershed is privately owned, full implementation of watershed land treatment practices (or BMPs) by every landowner in the watershed cannot be expected. The Daviess County Soil and Water Conservation District (SWCD) District Conservationist has been successful in encouraging landowners to implement conservation practices in the watershed.

However, an intermittent mosaic of watershed land treatment measures is expected to be implemented in the short term (5 years). To install BMPs on even half of the highly erodible acres in the watershed may take many more years to accomplish.

Even if BMPs were implemented on all of the highly erodible acres in the watershed (5,666.4 acres or 72% of the watershed), 100% of the sediments and nutrients would not be stabilized. Therefore, the installation of constructed wetland systems in the two tributaries, identified in the feasibility study as being responsible for transporting most of the nutrients and sediments to the lake, were recommended to trap residual nutrients and sediments prior to their discharge to West Boggs Lake. Thus, the purpose of this design project.

Existing Conditions

For purposes of the design project, and monitoring the success of the constructed wetlands, two parameters are the primary targets of improvement. Total suspended solids (TSS), or transparency, and total phosphorus (TP). Sediment and phosphorus, the limiting nutrient in aquatic systems, are the two parameters previously identified as being responsible for the eutrophication problems in West Boggs Lake. It can be assumed that significant reductions in TSS and TP will also result in significant reductions in the other parameters measured in previous limnological investigations.

The most recent measurements of transparency (Secchi depth) and TP in the lake water column were taken August 9, 1990. The Secchi depth was 1.8 feet. In the epilimnion (upper layer of water) the TP concentration was 0.063 ppm. In the hypolimnion (lower layer of water) the TP concentration was 0.509 with SD of 0.018. The average in-lake water column TP concentration was 0.29 ppm or mg/l.

In the feasibility study performed in 1990, samples of influent water were taken from seven tributary inlets to the Lake during a storm event. It is not known if these are first flush samples or how long it had been raining prior to taking the samples. Also it is implied in the feasibility study that the storm sampling was conducted in August of 1990. These are important variables to consider when attempting to compare future monitoring data.

The results showed the northwest branch of the Lake and the Shurn Creek branch as contributing the greatest storm event loading of suspended solids and nutrients to the Lake at the time of those sampling events.

Tributary TP and TSS Concentrations

Inlet	Total P	TSS
Area 1 Northwest inlet	2.80 mg/l	130 mg/l
Area 2 Shurn Creek inlet	2.70 mg/l	430 mg/l

These values can be referenced during post construction monitoring for the comparison of future discharge from the proposed, enhanced wetlands with baseline conditions.

5b Project Locations

West Boggs Lake is located in eastern Daviess County, 3 miles north of Loogootee Indiana just west of Hwy 231. There are two sites to receive structural controls to create sedimentation basins. Both areas are found on the U.S.G.S., Loogootee, Indiana quadrangle map.

The proposed Area 1 construction site is the upstream invert of the existing 13.5' x 8.5' corrugated, galvanized pipe arch beneath the St. Mary's Road bed. This pipe arch connects the backwaters of an unnamed creek arm of West Boggs Creek to the main body of West Boggs Lake. This site is located in Section 34, Township 4N., Range 5W.

The proposed Area 2 construction site is located in the Shurn Creek arm in the southwest part of West Boggs Lake. The site is located in Section 3, Township 3N, Range 5W.

5c Overall Description of the Project

The projects are designed to enhance the area, volume, and function of existing wetlands in each of the two project areas, to serve as sediment traps and to facilitate nutrient uptake from the incoming water by plants.

There are two primary activities in each project area. The Area 1 project consists of installing a pile of shot rock into the unnamed creek channel, to encourage flow distribution over a broader area of the enhanced wetlands, and the construction of a driven steel sheet piling dam with stop log outlets (constructed of steel H-beams and wood stop logs) in front of the existing pipe arch beneath St. Mary's Road. This is to raise the water elevation in the existing wetlands (west of St. Mary's Road) from 499.6 feet above mean sea level (MSL) to 502 feet above MSL.

The Area 2 project also includes a pile of shot rock dumped into the Shurn Creek channel to encourage flow distribution over a broader area of the enhanced wetlands, and the construction of a driven steel sheet piling dam with stop log outlets (constructed of steel H-beams and wood stop logs) downstream to increase the elevation of incoming water to increase the area and volume of the existing. The water level upstream of the dam will be increased from an existing 499.6 feet above MSL to a proposed 501.3 feet above MSL.

The proposed structures are intended to create an enhanced system of wetlands in their respective sub-basins by increasing water levels. These enhanced wetlands would serve as sedimentation basins and provide habitat for a hydrophytic plant community to utilize nutrients from the incoming water. This is to reduce both the sediment and nutrient loads to the main body of the lake.

5d Project Objectives and Design Considerations

Project Objectives

The overall objectives of the project are to maximize the detention time and trap efficiency in the given space owned by the Park Board and within the cost constraints of both the Park Board and the State Soil Conservation Board.

The concept behind retaining water in a constructed wetland or sedimentation basin is to reduce the suspension and transportation energy of moving waters. Water in motion has the capacity to scour and transport fine sediments (silts and clays) long distances before deposition. While a basin that has an inflow and an outflow cannot hold water motionless, the energy can be reduced sufficiently to facilitate the fallout of sediment from the water column.

Because of silty, clayey texture and the mineral nature of the soils in the West Boggs Lake watershed, the soils tend to maintain suspension for relatively long periods of time. This is called "colloidal suspension".

Water is a polar substance. That is, natural waters have a weak negative electrical charge. Inorganic clay particles (colloids) also possess a weak negative electrical charge. Therefore, the colloids tend to be repelled by the water molecules. Since the colloid has a greater density than water, it should readily be settled from nearly stationary water. However, the phenomena of colloidal suspension extends the duration of particle suspension. Therefore, an objective of this project is to hold the water in retention as long as possible. However, as with many projects of this nature, the limiting design constraints are budget, prevention of upstream floods of greater magnitude than conditions prior to construction, and allowable basin size rather than the theoretical settling time of suspended colloids.

Since we cannot bring the water to a completely motionless state, under most conditions, we must try to manipulate the flow to create hydraulic conditions more conducive to particle fallout. Two flow manipulation actions can be taken to facilitate particle fallout in a constructed wetland system; 1) discouraging turbulent, channelized flow through the system and encouraging broad quiescent sheet flow of water through the system; 2) and creating even resistance to flow throughout the system to reduce flow velocity and increase detention time.

Design Considerations

The following concepts are considered for optimal constructed wetland design.

- Significantly reduce the horizontal velocity of the water column.
- Reduce velocities of the inflow water as it enters the basins.
- Encourage sheet flow, rather than turbulent channelized flow.

- Encourage the uniform distribution of flow throughout the entire volume of the constructed wetland basin.

- Maximize contact of water with the substrate and vegetation in the wetland system to facilitate efficient nutrient uptake.

- Store as much water as possible, for as long as possible, from the largest feasible storm event.

- Structural stability and longevity. Resistance to hydraulic stress, erosive scour, and wave action.

- Minimization of operation and maintenance costs.

- Maximize safety of the operator and the general public.

- Optimizing the sites for fish and wildlife habitat suitability, if within construction budget.

- Minimize construction costs.

A common mistake in the design of constructed wetland systems is failing to provide adequate depth to support a variety of aquatic fauna year-round. In systems that are too shallow, the water column can go anaerobic when biochemical and biological oxygen demand depletes the water column of adequate oxygen to support a diverse aquatic community.

Because mosquito larvae breath atmospheric oxygen via a breathing tube, they can survive water with no dissolved oxygen. The natural predators of biting fly and mosquito larvaes (such as dragonfly and damselfly larvaes), and many other macroinvertabrates, breath dissolved oxygen from the water column through gills. To maintain balanced predator/prey relationships a variety of habitats and depths must be designed into the constructed wetland ecosystems.

To prevent having the wetland function as an unabated breeding ground for mosquitos, the system must be designed to either, drain entirely shortly after storm events, or have ample water depth (at least two feet) to ensure sufficient dissolved oxygen content throughout the year. In the case of each of the proposed structures, the only feasible alternative is to provide as much depth as possible without flooding upstream property illegally. Fortunately, each of the proposed sites have existing creek channels in them and some topographic relief for a contoured basin bottom.

5e Hydrology and Hydraulics

Introduction

The West Boggs Lake Enhancement Project required hydrology and hydraulic modeling to verify that no upstream property was legally flooded by the new

structures to be put in place. A 0.10 of a foot allowable increase in flooding depth of the upstream land was the primary design criteria upon which the hydraulics of the project were based. The first step in the design was calculating the 100-year 24-hour storm lake elevations for the entire existing West Boggs Lake through the duration of the storm under existing conditions. This was accomplished by using the SCS TR-20 Modeling Program and information provided by the USDA Soil Conservation Service. The input data was gathered from several sources. Most of the necessary input data was taken from the West Boggs Creek Watershed Protection and Flood Prevention Project (PL566) as built plans. The 100-Year 24-Hour storm rainfall of 6.31 inches was taken from the National Weather Services Technical Paper No. 40. The output from TR-20 gave the inflow and outflow hydrographs and the time versus stage relationship. It was necessary to know this due to the interaction of the main lake with the newly created sublakes.

Maximum Inflow	Maximum Outflow	Maximum State
8295 CFS	356 CFS	502.92 FT, MSL

The stage versus time relationship during a 100-Yr. 24-Hr. storm is Figure 1 on the following section. The computer printout of the TR-20 model can be seen in Appendix A.

Runoff Calculations

The next step in the modeling process developing was developing the inflow hydrographs for each of the proposed sublakes to be developed as sedimentation basins. SCS's TR-20 computer model was used once again. However, it was first necessary to calculate the time of concentration for each sedimentation basin. This was done by using overland flow, shallow concentrated flow, channelized flow, and wave velocity formulas as used by TR-55 to determine the time of concentration in hours.

Area 1 - Time of Conc.	Area 2 - Time of Conc.
2.01 Hours	2.37 Hours

The times of concentration, along with the drainage basin area (Maps 1 & 2), as shown in the following section, and the rainfall were entered in TR-20 and the inflow peaks into the sublakes were calculated. The actual rainfall inflow hydrographs (Figures 2 & 3) are presented in the following section. A complete computer printout of each TR-20 model can be found in Appendix B.

Area 1 (TR-20 Runoff Hydrograph)

	100 Year	10 Year	2 Year
Maximum Runoff (CFS)	1526	913	496

Area 2 (Shurn Creek)(TR-20 Runoff Hydrograph)

	100 Year	10 Year	2 Year
Maximum Runoff (CFS)	2282	1370	744

Area 1

From this point, both areas were looked at separately due to their different controlling structures and hydraulics. Area 1 was modelled first. To model the existing conditions with the pipe arch and causeway (which serves as a dam), it was necessary to use the modeling program, HY8 - Culverts from the Federal Highway Administration. Once all the necessary input for the culvert and road had been input in HY8, the stage versus outflow at different tailwater elevations was determined. The stage versus storage relationship and the stage vs. outflow was then entered into SCS TR-20, and the 100-Yr. 24-Hr. storm was routed through the sublake and the main lake with the culvert hydraulics adjusted to correlate to the main lake elevation at the time of peak outflow at the sublake. With the current road minimum elevation of 503.8 ft, road overtopping occurs in the 100-Yr. 24-Hr. storm. The maximum outflow from Area 1 at this existing condition is 1280.5 CFS which occurred at 13.77 hours at an elevation of 504.86 ft, with tailwater (main lake) elevation of approximately 500.8 FT at that time. The outflow hydrograph (Figure 4) and the time versus elevation relationship (Figure 5), plus the stage versus outflow graph (Figure 6) of the Area 1 sublake condition are shown in the next section as well as the routing spreadsheet (Table 1). The HY8 output can be seen in Appendix C.

With a modeled 100-Year storm elevation of 504.86 ft, there is approximately 1.06 FT of road overtopping at the lowest point of the road. According to HY8 at 504.86 FT, 647 CFS (51% of peak discharge) flows through the culvert and 633 CFS (49% of peak discharge) flows over the road. This sets the maximum water elevation at 504.96 FT. Several different weir lengths where modeled with the maximum allowable headwater elevation being 504.96. These ranged in length from 25 to 250 FT. It was determined that a 62 foot weir placed at 502.0 ft MSL would best meet the needs of Park Board while staying within 1/10 of a foot of the 100 year peak. By placing the weir at 502.0 FT., the storage was increased from 15.78 AC-FT to 46.63 AC-FT; approximately a 300% increase. This can be seen in the storage graph of Figure 7. With this weir, the 100 Yr. 24 Hr. Storm Elevation would only be increased by .08 ft. (504.94 FT. MSL). This increases the peak outflow from 1280 CFS to 1404 CFS (54% Road, 46% Culvert). The new outflow hydrograph (Figure 8) and the time versus elevation relationship (Figure 9), plus the stage versus outflow graph (Figure 10), as well as the routing spreadsheet (Table 3) are shown in the following section. This solution proves the most economical, viable option available that stays within the law. The TR-20 output for the existing and proposed conditions can be seen in Appendix D of this section.

Area 2

Area 2 (Shurn Creek) was much simpler to model since we know the water elevations of the existing lake are the same as the water elevations of the

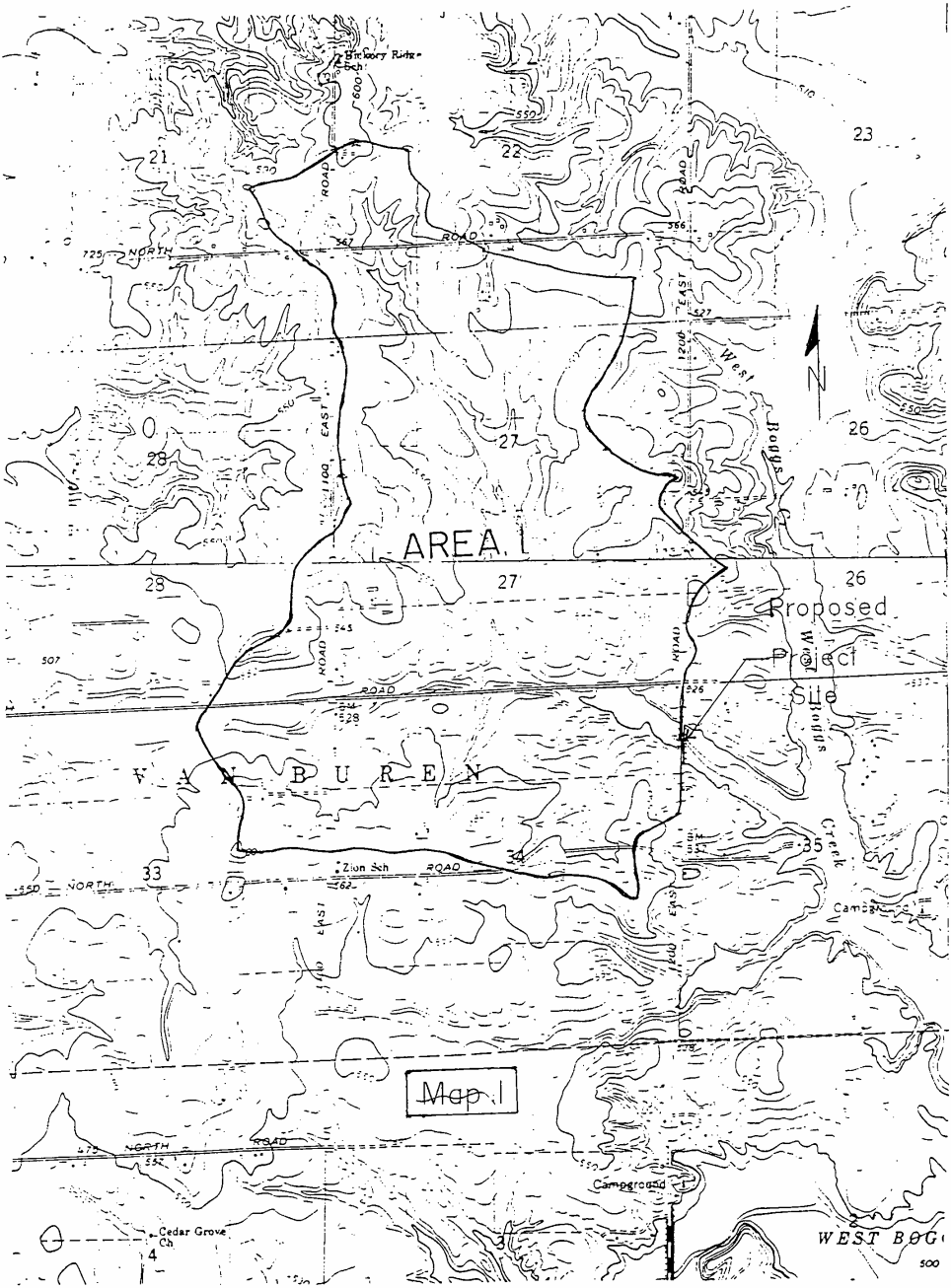
proposed sublake, and no hydraulic structures separate them. It was also much simpler since only one hydraulic structure was to be modeled in the proposed condition. The one difficulty of modelling this sublake was knowing at what point the weir becomes submerged, therefore changing the hydraulic modelling equation. For the part of the storm where the weir is free, the simple weir formula ($Q = CLH^{(3/2)}$) is used to model the flow over the weir. For the time of submerged weir flow, the submerged weir flow with end constrictions ($(Q/Q1=[1-(H2/H1)^{N}]^{0.385}$, $Q1=CH1^{(3/2)}$) is used to calculate the upstream height. Since the elevation of the top of the weir was set at 501.3 FT, due to normal pool constraints, it was necessary to find out at what time the main lake reached the elevation of the top of the weir, therefore switching the modelling equations. This occurs between 14 and 14.5 hours. The weir and sublake were modeled as a free weir formula up to 14.5 hours and as a submerged weir after that. The peak elevation obtained during free weir control was 502.5 FT at a flow of 2225 CFS. The relationship between flow over the weir and the depth of the sublake above the weir can be seen in Figure 11. However, since the elevation of the main lake continues to rise, the sublake continues to rise with it until it reaches essentially the same elevation as the main lake, 502.93 ft. The Area 2 routing spreadsheet (Table 3), outflow hydrograph (Figure 12) and the time versus stage graph (Figure 13) are shown in the next section. Figure 12 clearly shows that all flow is contained within the sublake for the first twelve hours, allowing settling during that time. The depth versus storage graph is Figure 14. The graph shows that the storage is increased from approximately 18 AC-FT to 67 AC-FT for the weir elevation; over a 400% increase. This means that the first 49 AC-FT of runoff from any storm is contained within the sublake. The TR-20 routing model for this sublake until the weir becomes submerged can be seen in Appendix E. This shows that the hydraulic structure does not raise the upstream 100-Year storm elevation at all, therefore meeting the one-tenth foot requirement. All the structure will cause is two peak elevations instead of one for the proposed sedimentation basin.

Conclusion

Neither of the proposed structures will effect the hydrology and hydraulics of the current dam in an adverse way, but they will reduce the maximum stage of the lake and the peak outflow at the dam for all storm events. This will occur due to the storage effect of the two structures. However, for the larger storms, when the downstream lake elevation exceeds the elevations of the proposed structures, they will likely become submerged and have a reduced effect on the main lake hydrology. The hydrology and hydraulics in the two sublakes can only decrease the severity of the downstream effects. This shows the new structures will have no adverse effects on the existing main dam.

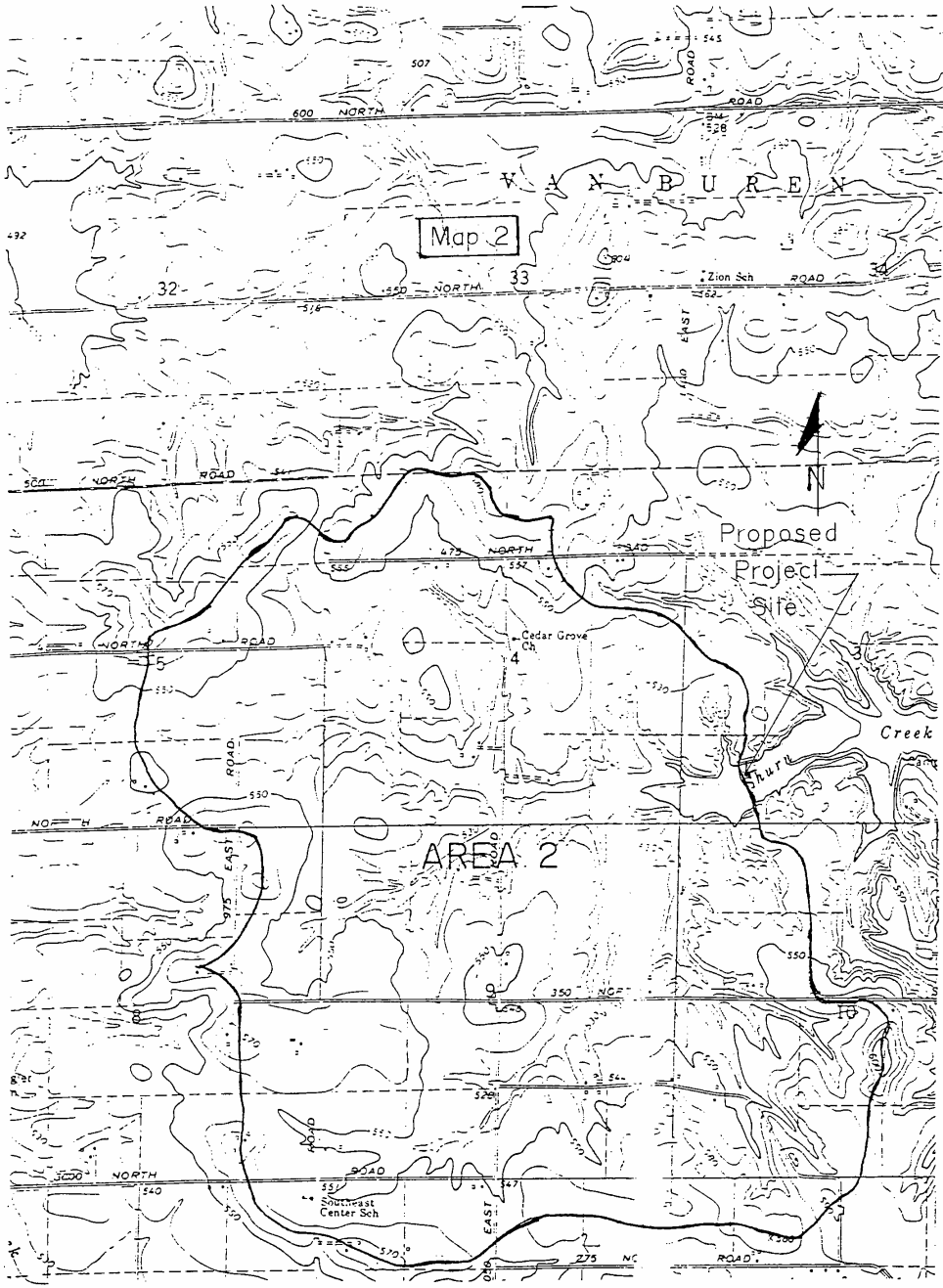
West Boggs Lake Water Elevation During 100 Year 24 Hour Storm Event
(Existing Conditions)
Data Generated By TR-20 Output
Peak Elevation = 502.92 FT
Total Rainfall Depth = 6.31 IN
Taken From NWS TP#40
Runoff Curve Number = 79
Time of Concentration = 2.77 Hours
Drainage Area = 13.27 Mi^2
Taken From W. Boggs Cr. Watershed
Protection and Flood Prevention
Project (PL566) By SCS
TR-20 24 Hour Type II Rainfall Curve Used
Lake Elevation (FT, MSL)
503
502.5
502
501.5
501
500.5
500
499.5
0
5
10
15
20
25
30
35
40
45
50
Time From the Beginning of the Storm (Hours)

Figure I



COMMONWEALTH ENGINEERS, INC.

West Boggs Lake Enhancement Design Project
Area 1 Drainage Basin Area = 1.93 Sq. Mi.
U.S.G.S. Map Scale 1 = 2000



COMMONWEALTH ENGINEERS, INC.

West Boggs Lake Enhancement Desing Project
Area 2 Drainage Basin Area = 3.27 Sq. Mi.
U.S.G.S. Map Scale 1 = 2000

Area 1 Inflow Hydrograph
(Existing Conditions)
Maximum Inflow Occurs at 13.16
Hours at a Peak of 1526
Drainage Area = 1.93 Mi^2
Delineated From the
U.S.G.S. Survey Map
Curve Number = 79
Taken From PL566
Time of Concentration = 2.01 Hours
Calculated From Overland,
Shallow Conc., Channel, and
Wave Velocity Formulas
Inflow (CFS)
Time From the Beginning of the Storm (Hours)
0
200
400
600
800
1000
1200
1400
1600
0
5
10
15
20
25
30
35

Figure 2

Area 2 Inflow Hydrograph (Shurn Creek Area)
(Existing Conditions)
Maximum Inflow Occurs at 14.43
Hours at a Peak of 2269 CFS
Drainage Area = 3.27 Mi^2
Delineated From the
U.S.G.S. Survey Map
Curve Number = 79
Taken From PL566
Time of Concentration = 2.37 Hours
Calculated From Overland
Shallow Conc., Channel, and
Wave Velocity Formulas
Inflow (CFS)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
Time From the Beginning of the Storm (Hours)

Figure 3

Area 1 Outflow Hydrograph
(Existing Conditions)
Maximum outflow occurs at 13.75 hours with a flow of 1279 CFS
Existing Conditions with Road Overflow
Assumes area 1 has an initial starting elevation of 499.6 FT (Same as Main Lake)
Outflow after this point is impossible to calculate due to interaction with the main lake
Outflow (CFS)
Time From the Beginning of Storm (Hours)
0
200
400
600
800
1000
1200
1400
0
5
10
15
20
25
30
35

Figure 4

Area 1 Water Elevation
(Existing Conditions)
Peak Water Elevation = 504.86 FT
at 13.75 hours into the storm
Minimum Road Elevation = 503.8 FT
(St. Mary's Road)
Road overtopping occurs for
approximately 3 hours at
depths up to 1.06 FT
Elevation controlled by storm
routing through hydraulic structures
Elevation controlled by downstream
lake elevation
Water Elevation (FT. MSL)
505
504
503
502
501
500
499
0
5
10
15
20
25
30
35
Time From the Beginning of the Storm (Hours)

Figure 5

Area 1 - Outflow Graph
(Existing Conditions)
Elevation (FT, MSL)
505
504.5
504
503.5
503
502.5
502
501.5
501
500.5
0
200
400
600
800
1000
1200
1400
Maximum Depth Due to Culvert and Road
Flow El = 504.86 FT
Q = 1279 CFS
Taken From HY8 Output Shown in Appendices
Flow Through the Existing Pipe Culvert and Over the Road (CFS)

Figure 6

Table 1

W. Boggs Lake - Area 1 Routing Spreadsheet

(Existing Conditions)

Time Hours	Lake Elevation Ft. MSL	Basin Inflow CFS	Basin Outflow CFS	Basin Elevation Ft. MSL
6	499.6	0	0	499.6
6.5	499.6	0.05	0.01	499.6
7	499.6	0.6	0.02	499.6
7.5	499.6	2.6	0.1	499.61
8	499.6	6.45	0.5	499.63
8.5	499.6	11.92	1	499.69
9	499.61	19.68	2.5	499.79
9.5	499.62	30.16	5	499.95
10	499.63	43.41	10	500.11
10.5	499.65	60.18	20	500.29
11	499.67	85.15	40	500.56
11.5	499.71	132.15	81.52	500.87
12	499.79	359.42	203.3	501.08
12.5	499.98	1004.98	391.37	501.98
13	500.27	1506.4	551.81	503.59
13.5	500.63	1425.31	1111.89	504.75
13.75	500.82	1236.29	1279.31	504.86
14	501.01	1030.31	1163.67	504.79
14.5	501.41	713.14	877.38	504.55
15	501.72	510.07	698.24	504.27
15.5	501.94	378.16	606.79	503.92
16	502.11	292.96	537.31	503.5
16.5	502.26	239.18	486.15	503.03
17	502.83	205.09	442	502.54
17.5	502.48	181.47	Outflow after	502.6
18	502.56	162.94	this point is	502.67
18.5	502.63	146.68	impossible to	502.71
19	502.67	134.31	calculate due to	502.75
19.5	502.71	124.76	interaction with	502.78
20	502.75	118.45	the main lake	502.8
20.5	502.77	111.91		502.83
21	502.8	103.27		502.85
21.5	502.82	95.42		502.88
22	502.84	90.44		502.89
22.5	502.85	87.87		502.9
23	502.87	86.52		502.91
23.5	502.88	85.83		502.92
24	50289	84.7		502.93
24.5	502.91	77.48		502.93
25	502.92	58.98		502.94
25.5	502.92	36.59		502.94
26	502.92	19.79		502.94
26.5	502.91	10.77		502.93

Table 1

W. Boggs Lake - Area 1 Routing Spreadsheet

(Existing Conditions)

Time	Lake Elevation	Basin Inflow	Basin Outflow	Basin Elevation
Hours	Ft. MSL	CFS	CFS	Ft. MSL
27	502.9	5.87		502.93
27.5	502.89	4.28		502.93
28	502.87	3.14		502.92
28.5	502.85	0.86		502.89
29	502.84	0.42		502.87
29.5	502.82	0.18		502.86
30	502.8	0.04		502.83
30.5	502.79	0		502.81
31	502.77			502.79
31.5	502.75			502.78
32	502.74			502.76
32.5	502.72			502.74
33	502.7			502.72
33.5	502.69			502.7
34	502.67			502.68
34.5	502.65			502.67
35	502.64			502.65
35.5	502.62			
36	502.6		Essentially same lake elevations.	
36.5	502.59		Just need minor head differential	
37	502.57		to drive water through culvert	
37.5	502.55			
38	502.53			
38.5	502.51			
39	502.5			
39.5	502.48			
40	502.46			
40.5	502.44			
41	502.43			
41.5	502.41			
42	502.39			
42.5	502.38			
43	502.36			
43.5	502.34			
44	502.32			
44.5	502.31			
45	502.29			
45.5	502.27			
46	502.26			
46.5	502.24			
47	502.23			
47.5	502.21			

Area 1 - Outflow Graph
(Existing Conditions)
Elevation (FT, MSL)
505
504.5
504
503.5
503
502.5
502
501.5
501
500.5
0
200
400
600
800
1000
1200
1400
Maximum Depth Due to Culvert and Road
Flow El = 504.86 FT
Q = 1279 CFS
Taken From HY8 Output Shown in Appendices
Flow Through the Existing Pipe Culvert and Over the Road (CFS)

Figure 6

Area 1 Storage
510
508
506
504
502
500
498
496
494
Stage (FT)
0
50
100
150
200
250
300
Storage (AC-FT)
0.95
3.23
6.92
11.05
18.83
29.6
46.63
66.37
89.49
115.92
144.32
174.16
205.06
287.05
270.95
Proposed Water Storage and Elevation
Vol = 46.63 AC-FT, El. = 502.0 FT
Current Water Storage and Elevation
Vol = 15.78 AC-FT, El. = 499.6 FT
Storage Within Park Easement

Figure 7

Area 1 Outflow Hydrograph
(Proposed Conditions)
Maximum outflow occurs at 13.75 hours with a flow of 1397 CFS
Existing Conditions with Road Overflow
Assumes area 1 has an initial starting elevation of 499.6 FT (Same as Main Lake)
Outflow after this point is impossible to calculate due to interaction with the main lake
Outflow (CFS)
Time From the Beginning of the Storm (Hours)
0
200
400
600
800
1000
1200
1400
0
5
10
15
20
25
30
35

Figure 8

Area 1 Water Elevation
(Proposed Conditions)
Peak Water Elevation = 504.93 FT
at 13.75 hours into the storm
Minimum Road Elevation = 503.8 FT
(St. Mary's Road)
Road overtopping occurs for
approximately 2.5 hours at
depths up to 1.13 FT
Elevation controlled by storm
routing through hydraulic structures
Elevation controlled by downstream
lake elevation
Water Elevation (FT. MSL)
Time From the Beginning of the Storm (Hours)
505
504
503
502
501
500
499
0
5
10
15
20
25
30
35

Figure 9

Area 1 - Outflow Graph
(Proposed Conditions)
Taken From HY8 Output Shown in Appendices
Plus Free Weir Calculations
Weir Formula (Q = C L H^(3/2))
C = 3.3, L = 62 FT
Maximum Depth Due
To Weir and Road
Flow El = 504.93 FT
Q = 1397 CFS
Flow Over Proposed Weir
and Through Existing Culvert
Flow Over Both Weir and Road
Elevation (FT, MSL)
505
504.5
504
503.5
503
502.5
502
0
200
400
600
800
1000
1200
1400
Flow Over Proposed Weir and Existing Road

Figure 10

Table 2

W. Boggs Lake - Area 1 Routing Spreadsheet

(Proposed Conditions)

Time Hours	Lake Elevation Ft. MSL	Basin Inflow CFS	Basin Outflow CFS	Basin Elevation Ft. MSL
6	499.6	0	0	499.6
6.5	499.6	0.05	0	499.6
7	499.6	0.6	0	499.6
7.5	499.6	2.6	0	499.61
8	499.6	6.45	0	499.63
8.5	499.6	11.92	0	499.69
9	499.61	19.68	0	499.79
9.5	499.62	30.16	0	499.95
10	499.63	43.41	0	500.1
10.5	499.65	60.18	0	500.29
11	499.67	85.15	0	500.56
11.5	499.71	132.15	0	500.9
12	499.79	359.42	0	501.47
12.5	499.98	1004.98	159.85	502.83
13	500.27	1506.4	731.46	504.33
13.5	500.63	1425.31	1396.72	504.93
14	501.01	1030.31	1177.72	504.79
14.5	501.41	713.14	878.14	504.55
15	501.72	510.07	698.44	504.27
15.5	501.94	378.16	559.99	503.96
16	502.11	292.96	446.68	503.66
16.5	502.26	239.18	358.29	503.41
17	502.83	205.09	291.85	503.22
17.5	502.48	181.47	243.79	503.08
18	502.56	162.94	208.85	502.98
18.5	502.63	146.68	182.37	502.9
19	502.67	134.31	161.79	502.84
19.5	502.71	124.76	147.22	502.79
20	502.75	118.45		502.8
20.5	502.77	111.91		502.83
21	502.8	103.27	Outflow after	502.85
21.5	502.82	95.42	this point is	502.88
22	502.84	90.44	impossible to	502.89
22.5	502.85	87.87	calculate due to	502.9
23	502.87	86.52	interaction with	502.91
23.5	502.88	85.83	the main lake	502.92
24	50289	84.7		502.93
24.5	502.91	77.48		502.93
25	502.92	58.98		502.94
25.5	502.92	36.59		502.94
26	502.92	19.79		502.94
26.5	502.91	10.77		502.93

Table 2

W. Boggs Lake - Area 1 Routing Spreadsheet

(Proposed Conditions)

Time	Lake Elevation	Basin Inflow	Basin Outflow	Basin Elevation
Hours	Ft. MSL	CFS	CFS	Ft. MSL
27	502.9	5.87		502.93
27.5	502.89	4.28		502.93
28	502.87	3.14		502.92
28.5	502.85	0.86		502.89
29	502.84	0.42		502.87
29.5	502.82	0.18		502.86
30	502.8	0.04		502.83
30.5	502.79	0		502.81
31	502.77			502.79
31.5	502.75			502.78
32	502.74			502.76
32.5	502.72			502.74
33	502.7			502.72
33.5	502.69			502.7
34	502.67			502.68
34.5	502.65			502.67
35	502.64			502.65
35.5	502.62			
36	502.6		Essentially same lake elevations.	
36.5	502.59		Just need minor head differential	
37	502.57		to drive water through culvert	
37.5	502.55			
38	502.53			
38.5	502.51			
39	502.5			
39.5	502.48			
40	502.46			
40.5	502.44			
41	502.43			
41.5	502.41			
42	502.39			
42.5	502.38			
43	502.36			
43.5	502.34			
44	502.32			
44.5	502.31			
45	502.29			
45.5	502.27			
46	502.26			
46.5	502.24			
47	502.23			
47.5	502.21			

Area 2 (Shurn Creek) - Free Weir Flow Graph
(Proposed Conditions)
H Depth of Water Above Sheet Pile Dam (FT)
Q Flow Over Sheet Pile Dam (CFS)
Maximum Depth Due
to Weir Structure
H = 502.49 FT, Q = 2224.91 CFS
Weir Formula (Q = C L H^(3/2))
C = 3.3, L = 520 FT
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
500
1000
1500
2000
2500

Figure 11

Table 3

W. Boggs Lake - Area 2 Routing Spreadsheet

(Proposed Conditions)

Time Hours	Lake Elevation Ft. MSL	Basin Inflow CFS	Basin Outflow CFS	Basin Elevation Ft. MSL
6	499.6	0	0	499.6
6.5	499.6	0.05	0	499.6
7	499.6	0.67	0	499.6
7.5	499.6	3.02	0	499.6
8	499.6	7.91	0	499.62
8.5	499.6	15.54	0	499.64
9	499.61	26.49	0	499.69
9.5	499.62	41.53	0	499.76
10	499.63	61.02	0	499.85
10.5	499.65	86.07	0	499.97
11	499.67	122.12	0	500.13
11.5	499.71	188.79	0	500.36
12	499.79	465.52	0	500.78
12.5	499.98	1203.83	310.81	501.62
13	500.27	2048.22	1631.01	502.26
13.5	500.63	2282.96	2208.93	502.48
* 13.75 *	500.82	2177.02	2224.91	502.49
14	501.01	1972.1	2110.79	502.44
14.5	501.41	1440.39	1631.76	502.29
15	501.72	510.07	1212.48	502.3
15.5	501.94	378.16	914.05	502.18
16	502.11	292.96	703.74	502.23
16.5	502.26	239.18	456.77	502.32
17	502.83	205.09	390.47	502.42
17.5	502.48	181.47	379.65	502.51
18	502.56	162.94	329.88	502.58
18.5	502.63	146.68	293.03	502.63
19	502.67	134.31	269.32	502.68
19.5	502.71	124.76	246.8	502.72
20	502.75	118.45	226.3	502.75
20.5	502.77	111.91	210.63	502.78
21	502.8	103.27	196.73	502.8
21.5	502.82	95.42	182.8	502.83
22	502.84	90.44	170.1	502.84
22.5	502.85	87.87	160.24	502.86
23	502.87	86.52	153.64	502.88
23.5	502.88	85.83	149.5	502.89
24	50289	84.7	146.84	502.9
24.5	502.91	77.48	142.91	502.91
25	502.92	58.98	131.3	502.92
25.5	502.92	36.59	108.21	502.92
26	502.92	19.79	79.4	502.93
26.5	502.91	10.77	52.95	502.93

Table 3

W. Boggs Lake - Area 2 Routing Spreadsheet

(Proposed Conditions)

Time	Lake Elevation	Basin Inflow	Basin Outflow	Basin Elevation
Hours	Ft. MSL	CFS	CFS	Ft. MSL
27	502.9	5.87	33.45	502.93
27.5	502.89	4.28	20.58	502.92
28	502.87	3.14	17.96	502.9
28.5	502.85	0.86	17.96	502.87
29	502.84	0.42	17.96	502.85
29.5	502.82	0.18	17.96	502.84
30	502.8	0.04	17.96	502.82
30.5	502.79	0	17.96	502.8
31	502.77		17.96	507.78
31.5	502.75		17.96	502.77
32	502.74		17.96	502.75
32.5	502.72		17.96	502.73
33	502.7		17.96	502.72
33.5	502.69			
34	502.67			
34.5	502.65			
35	502.64			
35.5	502.62			
36	502.6			
36.5	502.59			
37	502.57		Essentially same lake elevations.	
37.5	502.55		Just need minor head differential	
38	502.53		to drive water through culvert	
38.5	502.51			
39	502.5			
39.5	502.48			
40	502.46			
40.5	502.44			
41	502.43			
41.5	502.41			
42	502.39			
42.5	502.38			
43	502.36			
43.5	502.34			
44	502.32			
44.5	502.31			
45	502.29			
45.5	502.27			
46	502.26			
46.5	502.24			
47	502.23			
47.5	502.21			

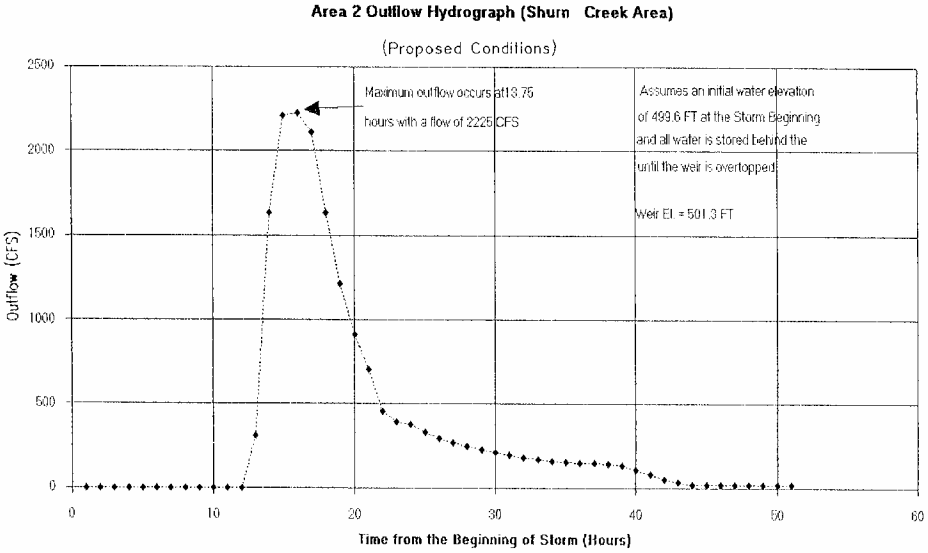

Area 2 Outflow Hydrograph (Shurm Creek Area)
(Proposed Conditions)
Maximum outflow occurs at13.75
hours with a flow of 2225 CFS
Assumes an initial water elevation
of 499.6 FT at the Storm Beginning
and all water is stored behind the
until the weir is overtopped.
Weir El = 501.3 FT
Outflow (CFS)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
Time from the Beginning of Storm (Hours)

Figure 12

Area 2 Water Elevation (Shurn Creek Area)
(Proposed Conditions)
Water Elevation (FT, MSL)
503
502.5
502
501.5
501
500.5
500
499.5
Peak Elevation Due to Weir Control = 502.49 FT
0
10
20
30
40
50
60
Time From the Beginning of the Storm (Hours)

Figure 13

Area 2 Storage (Shurn Creek Area)
505
504
503
502
501
500
499
490
Stage (FT)
0
50
100
150
200
250
300
Storage (AC-FT)
253.27
191.38
137.99
93.46
55.36
25.12
6.26
Current Water Storage and Elevation
Vol = 17.58 AC-FT, El = 499.6
Storage at Proposed Weir Elevation
Vol = 66.79 AC-FT, El = 501.3
Storage Within Park Easement

Figure 14

5f. Structural Stability Analysis

Given the simple nature of the designed sheet piling weirs there is no structural foundation supporting weight. The only structural considerations involved in either of the two weirs are the depth to which sheet piles are to be driven into the earth. This was explained in the soils analysis presented earlier in the Volume I, Contract Documents.

Steel Sheet Piling

The depth below the ground surface to drive the steel sheet pilings were based on the stability characteristics of the soil strata in the project sites. In the soils analysis report performed for this project, our geotechnical subconsultant explains in their report, in Volume I, that, the limiting factor to the stability of steel sheet piling for the West Boggs projects was the minimum depth to which steel sheeting was to be driven rather than the strength of materials. The materials specified are typically used in much more severe applications on the Great Lakes and on inland waterways.

Wood Stop Log Planks

The specification for wood stop planks calls for a four inch lateral thickness plank, with strength and longevity values at least as high as those for No.1 or structural select western red cedar.

When the lake is drawn down for periodic maintenance, or for a lower winter pool elevation, it is expected that the stop planks will be removed and any outlet structures will be opened to allow dewatering of the constructed wetland areas. If, for some reason, the stop planks were left in the outlet structures while the lake was dewatered the structures have been designed to withstand the head forces that could be expected in the worst case condition of a major storm event hitting the structures with the outlets closed and the main lake drained downstream of the structures.

5g. Structures

Alternative Strategies and Availability of Materials

Area 1

The decision to design a sheet pile structure was based on several reasons. One reason is that our corrected H&H modeling proved that the weir length needed to be at least 64 feet long to prevent illegally flooding upstream and to prevent increased occurrences of flood waters overtopping St. Mary's Road.

The use of sheet piling in Area 1 also gives the Park Board the option of bidding out both structures as one project. Similar equipment could be used at both sites, thus possibly reducing, or even eliminating, a second mobilization charge.

Operator safety and public safety are also improved by using the larger sheet piling structures over a smaller diameter outfall structure. The longer weir length spreads out the energy of the water discharging over the top of the weir so head heights and flow energy is greatly reduced. As the final plans depict, the operator pulling stop logs is kept almost twenty feet away from the opening of the pipe arch during maintenance.

Given the limited space at this site, an earthen dam would not be feasible.

Area 2

Alternative 1: Earthen Dam

The use of an earthen dam posed several potential problems in Area 2. Due to the vulnerability of the soil types found in Area 2 to piping, and bank instability, a suitable soil must be trucked at least 1/4 mile to the construction site. The soils identified as being suitable in the vicinity are not on lands owned by the Park Board, therefore the soil would have to be purchased from the landowner.

Again, due to the stability limitations of the soil (even that soil identified as suitable), considerable measure against piping and embankment failure would have to be taken to protect an earthen dam from erosion. For example, the side slopes would need to be a very gradual slope, at least two layers of a geogrid may have to be used to protect slope integrity, and the entire dam, including side slopes and the top, would have to be covered with a geofabric and rip-rap stone for its entire length. Also a relatively deep key trench would have to be dug and filled with impermeable clay to prevent undermining of the dam.

Preliminary feasibility calculations have shown the cost of such a dam to be far beyond the construction cost limitations of imposed by the budgets of the IDNR and the Park Board.

Alternative 2: Gabions

The installation of gabions across the Area 2 site was also considered. This option was dismissed after investigations into the water retention properties of gabions revealed their hydraulic conductivity rates exceeded the desired range for adequate pool retention. Gabions are also subject to the pores being filled with sediment in the lower energy portions of the dam. By reducing the hydraulic conductivity of the dam in lower energy areas the water will be forced through the open areas. This condition is not conducive to even flow distribution throughout the entire wetland system. Low energy portions of

the wetland would have much higher retention times than the higher energy areas which would pass the water too rapidly through the system. To prevent such a condition expensive flow routing controls would have to be installed upstream of the dam.

As one of the objectives of a constructed wetland system is to create an environment of even flow of water through the system, a considerable amount of excavation of the lake bottom would have to be performed to get the tops of the installed gabions to be level for even water retention properties.

Alternative 3: Steel Sheet Piling

After consideration of the of the above listed options, and following the advice of IDNR staff, the feasibility of using steel sheet piling as a dam material was examined. After researching the performance of sheet piling used in other water detention situations it was determined that this was the most feasible option for Area 2.

The desirable characteristics of steel sheet piling for this application include its strength, durability, and longevity in aquatic environments, speed and ease of installation and relative cost effectiveness. The hydraulic characteristics are also more favorable. The top of the sheet piling, it is considered a "sharp crested weir", therefore the "effective weir height" is not as high as a broader dam of the same elevation covered with a coarse material such as rip-rap. In other words, the actual the actual weir elevation can be set higher with a sharp crested weir than with low head dam with a longer weir surface and a coarse armor (rip-rap) top surface. This allows for a higher normal pool elevation thus a greater wetland volume upstream of the dam.

Steel sheet piling has been the material of choice for construction projects in navigable waters for decades. The majority of documented structural failures of steel sheet piling has been a result of collision with commercial shipping vessels rather than hydraulic stress causing structural failure.

One concern that Commonwealth staff had with steel sheet piling was its application in relatively acidic environments. The substrate of wetlands in Indiana can be expected to have a pH as low as 5.0. However, this material has been successfully in place for over 75 years in low pH environments throughout the lower Mississippi River system without excessive corrosion of sufficient magnitude to compromise the structural integrity of the pilings.

Design Constraints

Construction Costs

The major constraints to the design project are cost, space, and long term operation and maintenance costs.

In the Revised Policies for Indiana's "T By 2000" Lake Enhancement Program, Adopted August 14, 1990 by the State Soil Conservation Board, paragraph I-C.-5. reads as follows "Priority will be given to construction projects where the local entities provide a minimum of 25% of the total costs. In no case shall the State's input exceed $100,000 for a specific construction project or $300,000 for all construction projects on a given lake. Expenditures in excess of these amounts will require a special exception from the Board."

Also given the budget constraints of the Park Board, it is anticipated that the local match will not exceed 25% of the total project cost. Therefore the cost of each construction project should not exceed approximately $125,000.

The actual goal is to keep the cost of each structural control to a minimum while ensuring that the design will meet program objectives. This will allow the Park Board to divert funding into shoreline erosion control and O&M dredging of the constructed wetland basins in the future.

Available Space

It is the policy of IDNR to not allocate funding for property acquisition. Fortunately, the West Boggs Park Board owns the land approximately 100+/- feet from the normal high water mark of the lake. Since the Park Board lacks funds for the purchase of additional land, all construction activity and proposed constructed wetland area must be confined within the limits of property presently owned by the Park Board.

While "T By 2000" funds can be used to excavate a sedimentation basin site during initial construction, the policy of IDNR is to not allow the use of "T By 2000" funding for the deepening of a lake bottom through dredging. Therefore we cannot increase the volume of the wetland basin by making it deeper unless alternative sources of funding the dredging can be found.

Existing Structures

In Area 1, a major design consideration is to not have a negative impact on the structural integrity of the existing St. Mary's Road bed. According to "as-built" drawings supplied by Wayne Faust of the SCS state office, the road as built in the early 1970's, had a top crown elevation of 504.5 feet above MSL, and side slopes of 2:1. The as-built drawings identify the location of the original creek channel approximately 75 feet north of the existing pipe arch.

According to the one (1) foot contour interval topographic mapping of Area 1 developed for this design project, there is a low spot of approximately 503.8' in the road bed approximately at the place where the original creek channel passed beneath the roadbed. It is in this low area where the larger magnitude storms are projected to pass over the top of the road bed. In fact this did happen, in November 1993, after a storm event of approximately 100 year magnitude overtopped the road in this low area. As discussed earlier, the hydraulics modeling done for this project shows the St. Mary's Road bed being overtopped in storm events of approximately 100 year frequency. The November 1993 road overtopping demonstrates the accuracy of CEI's modeling. According to local accounts, the road suffered minor erosional damage from the overtopping.

Presently the St. Mary's Road bed is showing evidence of erosion on the side slopes. CEI recommends that the Park Board encourage the Daviess County Highway Department to re-establish original side slopes of the St. Mary's Road and install slope revetment such as rip-rap. Also, the original road height should be re-established to protect the road from future overtopping. It must be recognized that raising the elevation of the road to prevent overtopping may result in slightly increased flood elevations upstream.

The designed sheet piling dam in Area 1 has a weir length such that the elevation of the head of water above the top of the sheet piling is minimized (without excessive costs incurred for additional weir length). This is to ensure that the existing road bed does not have to support more hydraulic pressure than necessary in storm events of larger magnitude.

In the geotechnical analysis of soils in the project areas, Alt & Witzig Engineers (A&W) took a soil boring from the road bank to characterize the roadbed and subsurface materials at the Area 1 construction site (see boring location B-1 in the soils report). CEI consulted with the A&W project manager, Mr. Tom Coffey, P.E., on the ability of the existing road bed to withstand the additional 2.4 feet of normal pool elevation on the upstream side of the road. Based on their analysis, Mr. Coffey has no reservations in raising the normal pool elevation on upstream side of the existing St. Mary's Road bed. The structural stability of the roadbed is not expected to be adversely affected.

Daviess County Highway Department personnel have informed CEI that they have routine maintenance problems with the east side of the road bed from wave action, but that the east side has been relatively stable.

5h. Environmental Concerns

Wetlands

Due to the nature of the proposed projects, it is necessary to construct the structures in jurisdictional wetlands. However, the projects should prove to be beneficial to the wetland ecosystems since they are designed to enhance the area and volume of the existing wetlands. This will provide more of each functional value currently provided by the existing wetlands. Applications are

currently pending for permits from the U.S. Army Corps of Engineers for construction activity in the wetland areas.

Threatened or Endangered Species

According to the Indiana Department of Natural Resources, no threatened or endangered species of plants or animals are known to exist in the proposed project locations.

Operations and Maintenance Activities

The O&M dredging of the wetland basins will cause temporary damage to the aquatic benthic community. However, based on several studies done on other dredging projects the negative impacts are short lived with the benthic community recovering completely within a few seasons.

It has been demonstrated on dredging projects all over North American and Western Europe that the benefits of such dredging operations far outweigh the temporary negative impacts to the aquatic benthic community.

Given the heavy sedimentation of the subject areas, the construction or operations and maintenance projects will not be disturbing a high quality benthic community or a sand/gravel substrate.

5i. Flowage Easements

The acquisition of flowage easement in addition to those already in possession should not be necessary for the successful construction or long term operation of the designed structures.

5j. Special Materials Required

Steel Sheeting and H-Piles

The Steel sheet piling specified in the construction plans is Bethlehem Steel PZ-22 or a product of equal strength and characteristics. These materials are available from a wide variety of suppliers in the Midwest. The steel H-piles are also widely available in the Midwest. These materials are commonly used in similar applications on navigable waterways of the U.S. Any material substitutions suggested by the Contractor shall be required to be approved by the Engineer.

Wood Stop Logs

The material specified for the wood stop logs must have strength and longevity at least equal to western red cedar number 1 grade or structural select. There are a variety of woods that the Engineer will approve for this application.

5k. O & M Considerations That Have Affected Design

Stop Log Openings

The weirs have been designed with the stop log outlet structures in them to facilitate the complete draining of the basins for O&M purposes a well as for access for wildlife habitat enhancement projects in the future. Wood stop logs were specified in these openings rather than a synthetic material so, if the logs proved difficult to remove the operator has the option of using a chain saw to remove the planks.

The use of stop logs was preferred over a gate, since it may be as long as ten years between operating events. The likelihood of a gate becoming inoperable over this period of time in the given environment was very high. Stop logs are simple and long lived.

Steel Sheet Piling

This material was chosen over an earthen dam for several reasons. The optimal design for the structures were low head weirs rather than a dam with a single point discharge outlet structure. This allowed more even distribution of the residence time of water moving through the constructed wetland systems.

According to the Daviess County Soil Survey, due to the nature of soils in the watershed, suitable materials for an earthen dam would have to be trucked at least 1/4 mile from the Area 2 project site. And because of the instability of the soils the dam would have to be armored with rip-rap for its entire length. This considerably increases the initial construction costs, and the cost of operating and maintaining the structures.

Another objective was to maintain as high a pool elevation as possible after rain events behind the dams without illegally flooding upstream properties. As mentioned earlier, an armored dam surface the rough surface has creates a higher "effective weir height" than a smoother or sharper weir surface such as that provided by the sheet piling. In other words, the volume of water stored behind an earthen dam would necessarily be less than that behind a steel sheeting weir of the same height. So, the actual weir height could be set higher with steel sheet piling, thus a greater storage volume of water could be managed.

5l. Engineer's Estimate by Bid Item

Engineer's Estimated Construction Costs Area 1 Structure

Task	Cost/Unit	No. of Units Required	Total Costs
Dewatering	$121 / day	5 days	$605.00
Dumped Shot Rock	$41 / yd^3	27 yd^3	$1,107.00
Installation of Geofabric along Road	$2.33 / yd^2	34 / yd^2	$79.22
Placement of Rip-rap for Road Armor	22	34 / yd^2	$748.00
Installation of Steel Sheeting	$12 / ft^2	1750 / ft^2	$21,000.00
Installation of Geofabric Within Weir Area	$2.33 / yd^2	128 / yd^3	$298.24
Placement Shot Rip-rap within Weir Area	$22 / yd^2	128 / yd^3	$2,816.00
Grout Rip-rap in Front of Openings	$40 / yd^2	37 / yd^3	$1,480.00
Installation of Stop Logs	$290/outlet	2 outlets	$580.00
H. Piles	$20.50 / L.F.	80 L.F.	$1,640.00
Subtotal			$30,353.46
Mobilization			$8,000.00
TOTALS			$38,353.46

Engineer's Estimated Construction Costs Area 2 Structure

Task	Cost/Unit	No. of Units Required	Total Costs
Dewatering	$175 / day	5 days	$875.00
Dumped Shot Rock	$41 / yd^3	36.2 yd^3	$1,484.20
Installation of Geofabric on slopes at ends of weir	$2.33 / yd^2	70 / yd^2	$163.10
Placement of rip-rap on slopes at ends of weir on end slopes	$22 / yd^2	70 yd^2	$1,540.00
Installation of Steel Sheeting	$12 / ft^2	9375	$112,500.00
Installation of Geofabric Downstream of Outlets	2.33 / yd^2	67 yd^2	$156.11
Placement of Rip-rap Downstream of Outlets	$22 / yd^2	67 yd^2	$1,474.00
Grout Rip-rap Downstream of Openings	$40 / yd^2	67 yd^2	$2,680.00
Installation of Stop Logs	$290/outlet	6 Outlets	$1,740.00
H-Piles	$20.50 L.F.	160 L.F.	$3,280.00
Subtotal			$125,892.41
Mobilization			$8,000.00
TOTALS			$133,892.41

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

CERTIFICATE OF APPROVAL OF CONSTRUCTION IN A FLOODWAY

APPLICANT:
Daviess-Martin County Joint
Parks & Recreation Board
P.O. Box 245
Loogootee, IN 47553

AGENT:
Commonwealth Engineers, Inc.
Steve W. Chafin
7256 Company Drive
Indianapolis, IN 46237

STREAM:
UNT West Boggs Creek
(West Boggs Lake)

AUTHORITY:
IC 13-2-22, 310 IAC 6-1

PROJECT DESCRIPTION:
A steel sheet pile weir with 2 stop plank structures will be placed on the upstream side of the St. Marys Road culvert crossing. The weir will be of simi-circular shape with crest elevation at 502.0 feet, N.G.V.D. (normal pool at about 499.6 feet, N.G.V.D.). In addition, a 10-foot wide shot rock pile extending 15 feet on both banks will be placed across the creek at a point approximately 1,500 feet upstream of the proposed weir structure. Details of the project are shown on plans received at the Division of Water on September 2, 1993, December 15, 1993, June 15, 1994, and July 13, 1994.

PROJECT LOCATION:
At the upstream side of the C.R. 1200 East (St. Mary's Road) Crossing and at approximately 400 feet downstream of C.R. 600 North at/near Ragelsville, Van Buren Township, Daviess County
N½ NE¼, Section 34, T. 4N, R. 5W, Loogootee Quadrangle
UTM Coordinates: Downstream = 4288050 North, 505075 East, Upstream = 4288200 North, 504625 East

AUTHORIZATION AND APPEAL NOTICE:
This signed document constitutes the issuance of a permit by the Natural Resources Commission, or its designee, subject to the conditions as stated on the pages entitled "General Conditions" and "Specific Conditions". This permit or any of the conditions which it contains may be appealed by applying for administrative review. Such review is governed by the Administrative Orders and Procedures Act, IC 4-21.5, and by the Department's rules relating to adjudicative proceedings, 310 IAC 0.6. In order to obtain an appeal, a written petition must be filed within 18 days of the mailing of this notice. It should be addressed to:

Mr. Stephen L. Lucas, Director
Division of Hearings
Room W272
402 West Washington Street
Indianapolis, Indiana 46204

The petition should contain specific reasons for the appeal and indicate the portion(s) of the permit to which the appeal pertains. If an appeal is filed, the Natural Resources Commission will make the final agency determination following a legal proceeding conducted before an Administrative Law Judge.

August 12, 1994
Date

John N. Simpson, PE
Director
Division of Water

Documents prepared by: Jimmy Yee

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

SPECIFIC CONDITIONS

(1) other than those measures necessary to satisfy the "General" and "Specific" conditions, there shall be no deviation from the information received at the Division of Water on the following date(s) without the prior written approval of the Department of Natural Resources:

Information received: September 02, 1993, December 15, 1993, June 15, 1994, and July 13, 1994

(2) this approval shall become void if construction has not been initiated within 24 months from August 12, 1994

(3) seed and mulch all disturbed areas not protected by other methods

(4) maintain functional erosion and sediment control measures until all disturbed areas are stabilized

(5) seed and protect all disturbed streambanks with erosion control blankets as soon as possible to stabilize soil and enhance establishment of vegetation

(6) protect all 3:1 slopes or steeper with erosion control blankets as soon as possible after seeding when they are not protected by other methods

(7) seed and mulch all bare and disturbed areas as soon as possible after properly spreading the dredged material

(8) minimize and contain within the project limits all tree and brush clearing and provide the opportunity to utilize cleared trees of firewood and timber size

(9) if this project singly or cumulatively involves ¼ acre or more of tree (of any size) removal, a mitigation plan must be developed, approved, and implemented to provide reforestation at no less than a 2:1 acreage ratio

(10) revegetate all bare and disturbed areas with a mixture of grasses (excluding all varieties of tall fescue), legumes, and woody species upon completion

(11) minimize and contain within the project limits inchannel disturbance and the clearing of trees and brush

(12) revegetate disturbed banks as soon as possible after construction to prevent erosion

(13) do not leave felled trees, brush, or other debris in the floodway

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

GENERAL CONDITIONS

(1) This permit must be posted and maintained at the site of the permitted activity until the project is complete.

(2) If any archaeological artifacts or human remains are uncovered during construction, federal law and regulations (16 USC 470, et seq.; 36 CFR 800.11, et al) and state law (IC 14-3-3.4) require that work must stop and that the discovery must be reported to the Division of Historic Preservation and Archaeology within two (2) business days.

(3) This permit should not be construed as a waiver of any local ordinance or other state or federal laws.

(4) This permit does not relieve the permittee of the responsibility of obtaining additional permits, approvals, easements, etc. as required by other federal, state, and local agencies. These agencies include, but are not limited to:

U.S. Army Corps of Engineers, Louisville District
Indiana Department of Environmental Management
Daviess County Drainage Board
Local city or county planning and zoning commission

(5) This permit does not relieve the permittee of any liability for the effects which the project may have upon the safety of life and property of others.

(6) This permit may be revoked by the Department for violation by the applicant of any condition, or applicable statute or rule.

(7) This permit shall not be assignable or transferable without the prior, written consent of the Department.

(8) The Department shall have the right to enter upon the site of the permitted activity for the purpose of inspecting the authorized work.

(9) The receipt and acceptance of this permit by the applicant shall be considered as acceptance of all "General" and "Specific" conditions contained therein.

APPLICATION: FW-15,71

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

CERTIFICATE OF APPROVAL OF CONSTRUCTION IN A FLOODWAY

APPLICANT:
Daviess-Martin County Joint
Parks & Recreation Board
P.O. Box 245
Loogootee, IN 47553

AGENT:
Commonwealth Engineers, Inc.
Steve W. Chafin
7256 Company Drive
Indianapolis, IN 46237

STREAM:
Shurn Creek
(West Boggs Lake)

AUTHORITY:
IC 13-2-22, 310 IAC 6-1

PROJECT DESCRIPTION:
A steel sheet pile weir with three stop plank structures will be placed across the lake for the purpose of nutrient and sediment removal. The top of the weir will be at elevation 501.3 feet, N.G.V.D. (normal pool at about 499.6 feet, N.G.V.D.), In addition, a 10' wide shot rock pile extending 15 feet on both banks will be place across the creek at a point approximately 1,500 feet downstream of the C.R. 1050 West crossing. Details of the project are shown on plans received at the Division of Water on September 2, 1993, December 15, 1993, June 15, 1994, and July 13, 1994.

PROJECT LOCATION:
At approximately 3,700 feet east of C.R. 1050 East and about 3,100 feet north of C.R. 350 North (Downstream Limits)
at/near Ragelsville, Van Buren Township, Daviess County
E½, SW¼, SW¼, Section 3, T. 3N, R. 5W, Loogootee Quadrangle
UTM Coordinates: Downstream = 4285100 North, 503700 East, Upstream = 4285100 North, 503200 East

AUTHORIZATION AND APPEAL NOTICE:
This signed document constitutes the issuance of a permit by the Natural Resources Commission, or its designee, subject to the conditions as stated on the pages entitled "General Conditions" and "Specific Conditions". This permit or any of the conditions which it contains may be appealed by applying for administrative review. Such review is governed by the Administrative Orders and Procedures Act, IC 4-21.5, and by the Department's rules relating to adjudicative proceedings, 310 IAC 0.6. In order to obtain an appeal, a written petition must be filed within 18 days of the mailing of this notice. It should be addressed to:

Mr. Stephen L. Lucas, Director
Division of Hearings
Room W272
402 West Washington Street
Indianapolis, Indiana 46204

The petition should contain specific reasons for the appeal and indicate the portion(s) of the permit to which the appeal pertains. If an appeal is filed, the Natural Resources Commission will make the final agency determination following a legal proceeding conducted before an Administrative Law Judge.

August 12, 1994
Date

John N. Simpson, PE
Director
Division of Water

Documents prepared by: Jimmy Yee

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

SPECIFIC CONDITIONS

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(5) seed and protect all disturbed streambanks with erosion control blankets as soon as possible to stabilize soil and enhance establishment of vegetation

(6) protect all 3:1 slopes or steeper with erosion control blankets as soon as possible after seeding when they are not protected by other methods

(7) seed and mulch all bare and disturbed areas as soon as possible after properly spreading the dredged material

(8) minimize and contain within the project limits all tree and brush clearing and provide the opportunity to utilize cleared trees of firewood and timber size

(9) if this project singly or cumulatively involves ¼ acre or more of tree (of any size) removal, a mitigation plan must be developed, approved, and implemented to provide reforestation at no less than a 2:1 acreage ratio

(10) revegetate all bare and disturbed areas with a mixture of grasses (excluding all varieties of tall fescue), legumes, and woody species upon completion

(11) minimize and contain within the project limits inchannel disturbance and the clearing of trees and brush

(12) revegetate disturbed banks as soon as possible after construction to prevent erosion

(13) do not leave felled trees, brush, or other debris in the floodway

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

GENERAL CONDITIONS

(1) This permit must be posted and maintained at the site of the permitted activity until the project is complete.

(2) If any archaeological artifacts or human remains are uncovered during construction, federal law and regulations (16 USC 470, et seq.; 36 CFR 800.11, et al) and state law (IC 14-3-3.4) require that work must stop and that the discovery must be reported to the Division of Historic Preservation and Archaeology within two (2) business days.

(3) This permit should not be construed as a waiver of any local ordinance or other state or federal laws.

(4) This permit does not relieve the permittee of the responsibility of obtaining additional permits, approvals, easements, etc. as required by other federal, state, and local agencies. These agencies include, but are not limited to:

U.S. Army Corps of Engineers, Louisville District
Indiana Department of Environmental Management
Daviess County Drainage Board
Local city or county planning and zoning commission

(5) This permit does not relieve the permittee of any liability for the effects which the project may have upon the safety of life and property of others.

(6) This permit may be revoked by the Department for violation by the applicant of any condition, or applicable statute or rule.

(7) This permit shall not be assignable or transferable without the prior, written consent of the Department.

(8) The Department shall have the right to enter upon the site of the permitted activity for the purpose of inspecting the authorized work.

(9) The receipt and acceptance of this permit by the applicant shall be considered as acceptance of all "General" and "Specific" conditions contained therein.

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
P.O. BOX 59
LOUISVILLE, KENTUCKY 40201-0059

May 20, 1994

Operations and Readiness Division
Regulatory Branch (North)
ID No. 199301073-gdn

Mr. Robert Smolik
Daviess-Martin County Joint Park
and Recreation Board
P.O. Box 245
Loogootee, Indiana 47553

Dear Mr. Smolik:

Enclosed is Department of the Army (DA) Permit Number 199301073, authorizing the plan to place fill material in West Boggs Lake to facilitate the construction of water control structures. The purpose of the project is to raise the water elevation in order to increase the area and volume of wetlands and to reduce sediment and nutrient loading in the lake. The project is located along the causeway on St Mary's Road and within Section 34, Township 4 North, Range 5 West, in Daviess County, Indiana. Also enclosed is ENG Form 4336, "Notice of Authorization," which must be displayed at the construction site throughout construction.

Please indicate your acceptance of the terms and conditions of the permit by signing and dating both copies of the permit form on the lines provided for "Permittee" and "Date" and return one copy to us in the enclosed envelope. This permit will not be valid until we receive the signed copy. Upon completion of the work authorized under this permit, the enclosed Completion Report form must be completed and returned to this office.

Should any modification of the plans become necessary for any reason, approval from the District Engineer must be received prior to the start of the work. Copies of this letter will be sent to the appropriate coordinating agencies (see enclosure for addresses).

Sincerely,

Gerry Newell

Gerry Newell
Project Manager
Regulatory Branch

Enclosures

ADDRESSES FOR COORDINATING AGENCIES

Mr. Charles Orzehoskie
Chief, Wetlands Regulatory Unit
U.S. Environmental Protection Agency
Region V
77 West Jackson Boulevard
Chicago, Illinois 60604

Mr. Dave Hudak
Field Supervisor
U.S. Department of the Interior
Fish and Wildlife Service
620 South Walker Street
Bloomington, Indiana 47403-2121

Ms. Kathy Prosser
Commissioner
State of Indiana
Department of Environmental Management
P.O. Box 6015
Indianapolis, Indiana 46206-6015

Mr. Steve Jose
Environmental Supervisor
Division of Fish and Wildlife
Department of Natural Resources
402 West Washington Street, Room 273
Indianapolis, Indiana 46204

Mr. John N. Simpson, P.E., L.S.
Director
Division of Water
Indiana Department of Natural Resources
402 West Washington Street, Room W264
Indianapolis, Indiana 46204

Mr. Patrick R. Ralston
State Historic Preservation Officer
Indiana Department of Natural Resources
402 West Washington Street, Room 274
Indianapolis, Indiana 46204

DEPARTMENT OF THE ARMY PERMIT

Permittee: Daviess-Martin County Joint Park and Recreation Board

Permit No.: 199301073

Issuing Office: U.S. Army Engineer District, Louisville

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: To place fill material in West Boggs Lake to facilitate the construction of water control structures in order to raise the water elevation to increase the area and volume of existing wetlands. The project is located along the causeway on St. Mary's Road.

Project Location: Northeast Quarter of Section 34, Township 4 North, Range 5 West, on West Boggs Lake, in Daviess County, Indiana

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on May 31, 1997. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

a. The permittee shall comply with the conditions outlined in the Section 401 Water Quality Certification granted by the Indiana Department of Environmental Management, dated April 14, 1994 (copy attached).

b. The permittee shall ensure that all construction equipment is cleaned, maintained, and refueled at an upland site away from West Boggs Lake or any other drainageway, including wetland areas.

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

   a. Section 404 of the Clean Water Act (33 U.S.C. 1344).

2. Limits of this authorization.

   a. This permit does not obviate the need to obtain other Federal, state, or local authorization required by law.

   b. This permit does not grant any property rights or exclusive privileges.

   c. This permit does not authorize any injury to the property or rights of others.

   d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

   a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

   b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

   c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

   d. Design or construction deficiencies associated with the permitted work.

   e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

   a. Your failure to comply with the terms and conditions of this permit.

   b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

   c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The

referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit of the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

(PERMITTEE) *(DATE)* 6/24/94

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

HERBERT F. HARBACK
COLONEL, CORPS OF ENGINEERS

COMMANDER AND DISTRICT ENGINEER *(DATE)* 5-20-94

Gerry Newell

BY: Gerry Newell
Project Manager
Regulatory Branch

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

(TRANSFEREE) *(DATE)*

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
P.O. BOX 59
LOUISVILLE, KENTUCKY 40201-0059

May 24, 1994

Operations and Readiness Division
Regulatory Branch (North)
ID No. 199301075-gdn

Mr. Robert Smolik
Daviess-Martin County Joint Park
and Recreation Board
P.O. Box 245
Loogootee, Indiana 47553

Dear Mr. Smolik:

Enclosed is Department of the Army (DA) Permit Number 199301075, authorizing the plan to construct an aluminized metal sheet piling dam across the Shurn Creek embayment of West Boggs Lake. The project would also involve the construction of concrete bunkers within the Shurn Creek channel to reduce flow velocity within the channel. The project is located in Sections 3 and 4, Township 3 North, Range 5 West, near Loogootee, Daviess County, Indiana. Also enclosed is ENG Form 4336, "Notice of Authorization," which must be displayed at the construction site throughout construction.

Please indicate your acceptance of the terms and conditions of the permit by signing and dating both copies of the permit form on the lines provided for "Permittee" and "Date" and return one copy to us in the enclosed envelope. This permit will not be valid until we receive the signed copy. Upon completion of the work authorized under this permit, the enclosed Completion Report form must be completed and returned to this office.

Should any modification of the plans become necessary for any reason, approval from the District Engineer must be received prior to the start of the work. Copies of this letter will be sent to the appropriate coordinating agencies (see enclosure for addresses).

Sincerely,

Gerry Newell

Gerry Newell
Project Manager
Regulatory Branch

Enclosures

ADDRESSES FOR COORDINATING AGENCIES

Mr. Charles Orzehoskie
Chief, Wetlands Regulatory Unit
U.S. Environmental Protection Agency
Region V
77 West Jackson Boulevard
Chicago, Illinois 60604

Mr. Dave Hudak
Field Supervisor
U.S. Department of the Interior
Fish and Wildlife Service
620 South Walker Street
Bloomington, Indiana 47403-2121

Ms. Kathy Prosser
Commissioner
State of Indiana
Department of Environmental Management
P.O. Box 6015
Indianapolis, Indiana 46206-6015

Mr. Steve Jose
Environmental Supervisor
Division of Fish and Wildlife
Department of Natural Resources
402 West Washington Street, Room 273
Indianapolis, Indiana 46204

Mr. John N. Simpson, P.E., L.S.
Director
Division of Water
Indiana Department of Natural Resources
402 West Washington Street, Room W264
Indianapolis, Indiana 46204

Mr. Patrick R. Ralston
State Historic Preservation Officer
Indiana Department of Natural Resources
402 West Washington Street, Room 274
Indianapolis, Indiana 46204

DEPARTMENT OF THE ARMY PERMIT

Permittee: Daviess-Martin County Joint Park and Recreation Board

Permit No.: 199301075

Issuing Office: U.S. Army Engineer District, Louisville

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: To construct an aluminized metal sheet pile dam across the Shurn Creek embayment of West Boggs Lake. The purpose of the dam is to raise the water elevation to increase the size and volume of existing wetlands.

Project Location: The project is located on the Shurn Creek arm of West Boggs Lake, and within Sections 3 and 4, Township 3 North, Range 5 West, in Daviess County, Indiana.

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on May 31, 1997. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

a. The permittee shall comply with the conditions outlined in the Section 401 Water Quality Certification granted by the Indiana Department of Environmental Management, dated April 14, 1994 (copy attached).

b. The permittee shall ensure that all construction equipment is cleaned, maintained, and refueled at an upland site away from West Boggs Lake or any other drainageway, including wetland areas.

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

a. Section 404 of the Clean Water Act (33 U.S.C. 1344).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorization required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. Your failure to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit of the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

Bell & Associates 6/2/94

(PERMITTEE) *(DATE)*

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

HERBERT F. HARBACK
COLONEL, CORPS OF ENGINEERS

COMMANDER AND DISTRICT ENGINEER

5-25-94

(DATE)

Gerry Newell

BY: Gerry Newell
Project Manager
Regulatory Branch

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

(TRANSFEREE) *(DATE)*

DAVIESS-MARTIN COUNTY JOINT PARK AND RECREATION BOARD

WEST BOGGS LAKE ENHANCEMENT DESIGN PROJECT

INDIANA DEPARTMENT OF NATURAL RESOURCES PERMIT APPLICATION FOR CONSTRUCTION IN A FLOODWAY

DECEMBER 1993

COMMONWEALTH ENGINEERS, INC.

COMMONWEALTH ENGINEERS, INC.
Environmental Engineers & Consultants
7256 Company Drive
Indianapolis, Indiana 46237
Phone: (317) 888-1177
Fax #: (317) 887-8641

LETTER OF TRANSMITTAL

DATE 12/13/93	JOB NO. D9306
ATTENTION Ms. Julie Perry	
RE West Boggs Lake	

TO: IDNR, Division of Water
402 West Washington Street, RM 264
Indianapolis, IN 46204

GENTLEMEN:
WE ARE SENDING YOU ☐ ATTACHED ☒ UNDER SEPARATE COVER VIA UPS THE FOLLOWING ITEMS:
☐ SHOP DRAWINGS ☐ PRINTS ☐ PLANS ☐ SAMPLES ☐ SPECIFICATIONS
☐ COPY OF LETTER ☐ CHANGE ORDER ☐

COPIES	DATE	NO.	DESCRIPTION
25			Returned "Green Card" certified mail return receipts from affected parties.
1			Check for $50.00 application fee
1			Hydrology and Hydraulics Modeling Report for both Areas 1 and 2.
2			Permit Applications with "Statement of Affirmation" signed.
1			Detailed Plans for hydraulic control weirs and erosion control.

THESE ARE TRANSMITTED AS CHECKED BELOW:
☐ FOR APPROVAL ☐ REVIEWED ☐ RESUBMIT _____ COPIES FOR APPROVAL
☐ FOR YOUR USE ☐ FURNISH AS CORRECTED ☐ SUBMIT _____ COPIES FOR DISTRIBUTION
☐ AS REQUESTED ☐ REVISE AND RESUBMIT ☐ RETURN _____ CORRECTED PRINTS
☐ FOR REVIEW AND COMMENT ☐ REJECTED ☐ PRINTS RETURNED AFTER LOAN TO US
☐ FOR BIDS DUE _____ 19__ ☐

REMARKS Dear Ms. Perry: The enclosed items listed above were requested in vour 9/22/93 and 10/26/93 abevance notice. I have forwarded the two original to Bob Smolik of West Boggs Park for his signature on the " Statement of Affirmation". These signed applications will be forwarded as soon as I receive them back.

Thank You,

COPY TO file/chron./Bob Smolik /Mike Massonne

Steve Chafin

(If enclosures are not as noted, kindly notify us at once.)

PERMIT APPLICATION FOR CONSTRUCTION IN A FLOODWAY
State Form 42946 (R/4-91)
Approved by the State Board of Accounts, 1989

Mail To: Division of Water
Department of Natural Resources
402 West Washington Street, Room W264
Indianapolis, Indiana 46204
Telephone: (317) 232-5660

NEC SEC 17 T1 R1
CE 17123

REQUIREMENT FOR ADDITIONAL INFORMATION AND PERMITS

Application made to and approval granted by the Department of Natural Resources does not in any way relieve the applicant of the necessity of securing easements or other property rights, permits and approvals from affected property owners and other local, state, and federal agencies.

1. APPLICANT INFORMATION		2. AGENT OR ENGINEER INFORMATION	
Name of Applicant: Daviess-Martin County Joint Park and Recreation Board		Name of Agent or Engineer: Commonwealth Engineers, Inc.	
Address (Street, P.O. Box or Rural Route): P.O. Box 245		Address (Street, P.O. Box or Rural Route): 7256 Company Drive	
City, state and ZIP code: Loogootee, Indiana 47553		City, state and ZIP code: Indianapolis, Indiana 46237	
Home Telephone Number: ( )	Work Telephone Number: (812) 295-3421	Work Telephone Number: (317) 888-1177	

3. LOCATION OF THE PROPOSED PROJECT

Body of Water: West Boggs Creek Lake Area 1	U.S.G.S. Quadrangle Map: Loogootee, Indiana	
County: Daviess	Quarter Section (Check one): ☒ NE ☐ NW ☐ SE ☐ SW	Section or Grant: 34
Civil Township: VanBuren	Township (Check direction): 4 ☒ N or ☐ S	Range (Check direction): 5 ☐ E or ☒ W
Nearest City or Town: Loogootee, Indiana		

Additional location information (distance from major roadways, bridges, landmarks, etc.)
on the west side of the causeway along St. Mary's Road.

4. NATURE OF THE PROPOSED PROJECT

- ☐ Access Channel
- ☐ Bridge or Culvert
- ☐ Building
- ☐ Dam or Impoundment
- ☐ Excavation
- ☐ Fill
- ☐ Flood Control
- ☐ Levee
- ☐ Mining
- ☐ Outfall Structure
- ☐ Residence Addition
- ☐ Seawall or Bank Protection
- ☐ Utility

☒ Other, please specify:

Flow regime modification structure over a 8.5' X 13.5' pipe arch beneath St. Mary's Road connecting an unnamed creek arm to the main body of West Boggs Lake.

5. PURPOSE OF THE PROPOSED PROJECT

State the purpose, necessity, and description of the proposed activity

The objective of this project is to increase the volume and area of the existing wetland on the west side of St. Mary's Road for the purpose of removing sediments and nutrients from the watershed runoff prior to its discharge into West Boggs Lake. This is part of an IDNR Lake Enhancement project to reduce the documented excessive sediment and nutrient loading to West Boggs Lake.

6. NAMES AND ADDRES S OF THE PROPERTY OWNER AND ADJC NG LANDOWNERS

Provide the name and address of the property owner where the proposed activity will be conducted and list adjoining land owners which may be affected by the proposed project. Use additional sheets if necessary. Failure to list the property owner(s) and each adjoining landowner may cause a permit issued by the Department to later become voided.

Property Owner(s) Daviess-Martin County Joint Park & Recr Board	Adjoining Landowner #1 Howard Stoll
Address (Street, P.O. Box or Rural Route) P.O. Box 245	Address (Street, P.O. Box or Rural Route) R.R. 3
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 47553
Adjoining Landowner #2 Marlin Knepp	Adjoining Landowner #3 Paul Miller
Address (Street, P.O. Box or Rural Route) R.R. 3, Box 304	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Montgomery, Indiana 47558
Adjoining Landowner #4 David V. Wagler	Adjoining Landowner #5 Bernie Duncheon
Address (Street, P.O. Box or Rural Route) R.R. 3	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Montgomery, Indiana 47558
Adjoining Landowner #6 Joseph Kemp	Adjoining Landowner #7 Brian Traylor
Address (Street, P.O. Box or Rural Route) R.R. 3, Box 292	Address (Street, P.O. Box or Rural Route) Box 64
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Montgomery, Indiana 47558
Adjoining Landowner #8 Richard J. Taylor	Adjoining Landowner #9 Henry Wittmer
Address (Street, P.O. Box or Rural Route) R.R. 3, Box 302	Address (Street, P.O. Box or Rural Route) R. R. 1
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Montgomery, Indiana 47558
Adjoining Landowner #10 Rex Moyer	Adjoining Landowner #11 Noah Wittmer
Address (Street, P.O. Box or Rural Route) 315 Eastgate	Address (Street, P.O. Box or Rural Route) R.R. 1
City, state and ZIP code Vincennes, Indiana 47591	City, state and ZIP code Montgomery, Indiana 47558

7. ADDITIONAL INFORMATION

Corps Public Notice #_____, IDNR Early Coordination #_____

8. STATEMENT OF AFFIRMATION

I hereby swear or affirm, under the penalties for perjury, that the information submitted herewith is to the best of my knowledge and belief, true, accurate and complete, and that the property owner(s), and adjoining landowners have been notified of the project.

Robert E. Knebel 12/14/93

State Form 42948 (R/4-91)
Approved by the State Board of Accounts, 1989

Mail To:
Division of Water
Department of Natural Resources
402 West Washington Street, Room W264
Indianapolis, Indiana 46204
Telephone: (317) 232-5660

REQUIREMENT FOR ADDITIONAL INFORMATION AND PERMITS

Application made to and approval granted by the Department of Natural Resources does not in any way relieve the applic
of the necessity of securing easements or other property rights, permits and approvals from affected property owners a
other local, state, and federal agencies.

1. APPLICANT INFORMATION

Name of Applicant: Daviess-Martin County Joint Park and Recreation Board
Address (Street, P.O. Box or Rural Route): P.O. Box 245
City, state and ZIP code: Loogootee, Indiana 47553
Home Telephone Number: ( )
Work Telephone Number: (812) 295-3421

2. AGENT OR ENGINEER INFORMATION

Name of Agent or Engineer: Commonwealth Engineers, Inc.
Address (Street, P.O. Box or Rural Route): 7256 Company Drive
City, state and ZIP code: Indianapolis, Indiana 46237
Work Telephone Number: (317) 888-1177

3. LOCATION OF THE PROPOSED PROJECT

Body of Water: West Boggs Creek Lake Area 2
County: Daviess
U.S.G.S. Quadrangle Map: Loogootee, Indiana
Civil Township: Barr
Quarter Section (Check one): ☐ NE ☐ NW ☒ SE ☐ SW
Section or Grant: 4
Nearest City or Town: Loogootee, Indiana
Township (Check direction): 3 ☒ N or ☐ S
Range (Check direction): 5 ☐ E or ☒ W
Additional location information (distance from major roadways, bridges, landmarks, etc.): Approximately 1/2 mile east of County Road 1050 East.

4. NATURE OF THE PROPOSED PROJECT

☐ Access Channel
☐ Bridge or Culvert
☐ Building
☒ Dam or Impoundment
☐ Excavation
☐ Fill
☐ Flood Control
☐ Levee
☐ Mining
☐ Outfall Structure
☐ Residence Addition
☐ Seawall or Bank Protection
☐ Utility
☐ Other, please specify:

5. PURPOSE OF THE PROPOSED PROJECT

State the purpose, necessity, and description of the proposed activity

The objective of this project is to create an open water, palustrine wetland system between County Road 1050 East on the west, and West Boggs Lake on the east, for the purpose of retaining sediments and nutrients from the watershed runoff prior to its discharge into West Boggs Lake. This is part of an IDNR Lake Enhancement project to reduce the documented sediment and nutrient loading to West Boggs Lake.

6. NAMES AND ADDRESSES OF THE PROPERTY OWNER AND ADJOINING LANDOWNERS

Provide the name and address of the property owner where the proposed activity will be conducted and list adjoining landowners which may be affected by the proposed project. Use additional sheets if necessary. Failure to list the property owner(s) and each adjoining landowner may cause a permit issued by the Department to later become voided.

Property Owner(s) Daviess-Martin County Joint Park & Recr Board	Adjoining Landowner #1 Edwin Knepp
Address (Street, P.O. Box or Rural Route) P.O. Box 245	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 47553
Adjoining Landowner #2 Rebecca Knepp	Adjoining Landowner #3 Herman Graber
Address (Street, P.O. Box or Rural Route) R.R. 2, Box 145	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 46553
Adjoining Landowner #4 Mark Hopkins	Adjoining Landowner #5 Hubert Hopkins
Address (Street, P.O. Box or Rural Route) R.R. 2	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 47553
Adjoining Landowner #6 Paul Hopkins	Adjoining Landowner #7 Mary Margaret Vinevard
Address (Street, P.O. Box or Rural Route) R.R. 2	Address (Street, P.O. Box or Rural Route) 1707 Chalcdony Street, Apt. 14
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code San Diego, California 92109
Adjoining Landowner #8 Eli Graber	Adjoining Landowner #9 Amos Wagler
Address (Street, P.O. Box or Rural Route) R.R. 2	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 47553
Adjoining Landowner #10 Norman Wagler	Adjoining Landowner #11 Kenny & Ann Hedrick
Address (Street, P.O. Box or Rural Route) R.R. 2	Address (Street, P.O. Box or Rural Route) R.R. 3
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, IN 47553

7. ADDITIONAL INFORMATION

Corps Public Notice #_____, IDNR Early Coordination #_____

8. STATEMENT OF AFFIRMATION

I hereby swear or affirm, under the penalties for perjury, that the information submitted herewith is to the best of my knowledge and belief, true, accurate and complete, and that the property owner(s) and adjoining landowners have been notified of the project.

Signed Robert E. Smith Date 12/14/93

COMMONWEALTH ENGINEERS, INC.

9592

INVOICE NO.	DATE	DESCRIPTION	AMOUNT	DISCOUNT	NET AMT
WEST B0685	12/13/93	Const.Floodway Permi	50.00		50.00
			TOTAL =		$50.00

IDNR IDNR, Division of Water DATE: 12/13/93 CHECK NUMBER: 9592

COMMONWEALTH ENGINEERS, INC.
7256 COMPANY DRIVE
INDIANAPOLIS, IN 46237

BANK ONE, INDIANAPOLIS, NA
INDIANAPOLIS, INDIANA 46277
20-1-740

9592

9592

**** FIFTY & NO/100 DOLLARS
DATE AMOUNT

PAY TO THE ORDER OF IDNR, Division of Water

12/13/93 *******50.00

⑈009592⑈ ⑆074000010⑆ 24 55307⑈

PERMIT APPLICATION FOR CONSTRUCTION IN A FLOODWAY
State Form 42946 (RU4-91)
Approved by the State Board of Accounts, 1989

Mail To: Division of Water
Department of Natural Resources
402 West Washington Street, Room W264
Indianapolis, Indiana 46204
Telephone: (317) 232-5660

REQUIREMENT FOR ADDITIONAL INFORMATION AND PERMITS

Application made to and approval granted by the Department of Natural Resources does not in any way relieve the applicant of the necessity of securing easements or other property rights, permits and approvals from affected property owners and other local, state, and federal agencies.

1. APPLICANT INFORMATION

Name of Applicant: Daviess-Martin County Joint Park and Recreation Board
Address (Street, P.O. Box or Rural Route): P.O. Box 245
City, state and ZIP code: Loogootee, Indiana 47553
Home Telephone Number: ( )
Work Telephone Number: (812) 295-3421

2. AGENT OR ENGINEER INFORMATION

Name of Agent or Engineer: Commonwealth Engineers, Inc.
Address (Street, P.O. Box or Rural Route): 7256 Company Drive
City, state and ZIP code: Indianapolis, Indiana 46237
Work Telephone Number: (317) 888-1177

3. LOCATION OF THE PROPOSED PROJECT

Body of Water: West Boggs Creek Lake Area 1
U.S.G.S. Quadrangle Map: Loogootee, Indiana
County: Daviess
Quarter Section (Check one): ☒ NE ☐ NW ☐ SE ☐ SW
Section or Grant: 34
Civil Township: VanBuren
Township (Check direction): 4 ☒ N or ☐ S
Range (Check direction): 5 ☐ E or ☒ W
Nearest City or Town: Loogootee, Indiana
Additional location information (distance from major roadways, bridges, landmarks, etc.): on the west side of the causeway along St. Mary's Road.

4. NATURE OF THE PROPOSED PROJECT

- ☐ Access Channel
- ☐ Bridge or Culvert
- ☐ Building
- ☐ Dam or Impoundment
- ☐ Excavation
- ☐ Fill
- ☐ Flood Control
- ☐ Levee
- ☐ Mining
- ☐ Outfall Structure
- ☐ Residence Addition
- ☐ Seawall or Bank Protection
- ☐ Utility

☒ Other, please specify:

Flow regime modification structure over a 8.5' X 13.5' pipe arch beneath St. Mary's Road connecting an unnamed creek arm to the main body of West Boggs Lake.

5. PURPOSE OF THE PROPOSED PROJECT

State the purpose, necessity, and description of the proposed activity

The objective of this project is to increase the volume and area of the existing wetland on the west side of St. Mary's Road for the purpose of removing sediments and nutrients from the watershed runoff prior to its discharge into West Boggs Lake. This is part of an IDNR Lake Enhancement project to reduce the documented excessive sediment and nutrient loading to West Boggs Lake.

6. NAMES AND ADDRESSES OF THE PROPERTY OWNER AND ADJOINING LANDOWNERS

Provide the name and address of the property owner where the proposed activity will be conducted and list adjoining landowners which may be affected by the proposed project. Use additional sheets if necessary. Failure to list the property owner(s) and each adjoining landowner may cause a permit issued by the Department to later become voided.

Property Owner(s) Daviess-Martin County Joint Park & Recr Board	Adjoining Landowner #1 Howard Stoll
Address (Street, P.O. Box or Rural Route) P.O. Box 245	Address (Street, P.O. Box or Rural Route) R.R. 3
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 47553
Adjoining Landowner #2 Marlin Knepp	Adjoining Landowner #3 Paul Miller
Address (Street, P.O. Box or Rural Route) R.R. 3, Box 304	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Montgomery, Indiana 47558
Adjoining Landowner #4 David V. Wagler	Adjoining Landowner #5 Bernie Duncheon
Address (Street, P.O. Box or Rural Route) R.R. 3	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Montgomery, Indiana 47558
Adjoining Landowner #6 Joseph Kemp	Adjoining Landowner #7 Brian Traylor
Address (Street, P.O. Box or Rural Route) R.R. 3, Box 292	Address (Street, P.O. Box or Rural Route) Box 64
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Montgomery, Indiana 47558
Adjoining Landowner #8 Richard J. Taylor	Adjoining Landowner #9 Henry Wittmer
Address (Street, P.O. Box or Rural Route) R.R. 3, Box 302	Address (Street, P.O. Box or Rural Route) R. R. 1
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Montgomery, Indiana 47558
Adjoining Landowner #10 Rex Moyer	Adjoining Landowner #11 Noah Wittmer
Address (Street, P.O. Box or Rural Route) 315 Eastgate	Address (Street, P.O. Box or Rural Route) R.R. 1
City, state and ZIP code Vincennes, Indiana 47591	City, state and ZIP code Montgomery, Indiana 47558

7. ADDITIONAL INFORMATION

Corps Public Notice #_____, IDNR Early Coordination #_____

8. STATEMENT OF AFFIRMATION

I hereby swear or affirm, under the penalties for perjury, that the information submitted herewith is to the best of my knowledge and belief, true, accurate and complete, and that the property owner(s), and adjoining landowners have been notified of the project.

PERMIT APPLICATION FOR CONSTRUCTION IN A FLOODWAY
State Form 42946 (7-81)
Approved by the State Board of Accounts, 1989

Mail To: Division of Water
Department of Natural Resources
402 West Washington Street, Room W264
Indianapolis, Indiana 46204
Telephone: (317) 232-5660

REQUIREMENT FOR ADDITIONAL INFORMATION AND PERMITS

Application made to and approval granted by the Department of Natural Resources does not in any way relieve the applicant of the necessity of securing easements or other property rights, permits and approvals from affected property owners and other local, state, and federal agencies.

1. APPLICANT INFORMATION		2. AGENT OR ENGINEER INFORMATION	
Name of Applicant: Daviess-Martin County Joint Park and Recreation Board		Name of Agent or Engineer: Commonwealth Engineers, Inc.	
Address (Street, P.O. Box or Rural Route): P.O. Box 245		Address (Street, P.O. Box or Rural Route): 7256 Company Drive	
City, state and ZIP code: Loogootee, Indiana 47553		City, state and ZIP code: Indianapolis, Indiana 46237	
Home Telephone Number: ( )	Work Telephone Number: (812) 295-3421	Work Telephone Number: (317) 888-1177	

3. LOCATION OF THE PROPOSED PROJECT		
Body of Water: West Boggs Creek Lake Area 2	U.S.G.S. Quadrangle Map: Loogootee, Indiana	
County: Daviess	Quarter Section (Check one): ☐ NE ☐ NW ☒ SE ☐ SW	Section or Grant: 4
Civil Township: Barr	Township (Check direction): 3 ☒ N or ☐ S	Range (Check direction): 5 ☐ E or ☒ W
Nearest City or Town: Loogootee, Indiana		
Additional location information (distance from major roadways, bridges, landmarks, etc.): Approximately 1/2 mile east of County Road 1050 East.		

4. NATURE OF THE PROPOSED PROJECT

- ☐ Access Channel
- ☐ Bridge or Culvert
- ☐ Building
- ☒ Dam or Impoundment
- ☐ Excavation
- ☐ Fill
- ☐ Flood Control
- ☐ Levee
- ☐ Mining
- ☐ Outfall Structure
- ☐ Residence Addition
- ☐ Seawall or Bank Protection
- ☐ Utility
- ☐ Other, please specify:

5. PURPOSE OF THE PROPOSED PROJECT

State the purpose, necessity, and description of the proposed activity

The objective of this project is to create an open water, palustrine wetland system between County Road 1050 East on the west, and West Boggs Lake on the east, for the purpose of retaining sediments and nutrients from the watershed runoff prior to its discharge into West Boggs Lake. This is part of an IDNR Lake Enhancement project to reduce the documented sediment and nutrient loading to West Boggs Lake.

6. NAMES AND ADDRESSES OF THE PROPERTY OWNER AND ADJOINING LANDOWNERS

Provide the name and address of the property owner where the proposed activity will be conducted and list adjoining landowners which may be affected by the proposed project. Use additional sheets if necessary. Failure to list the property owner(s) and each adjoining landowner may cause a permit issued by the Department to later become voided.

Property Owner(s) Daviess-Martin County Joint Park & Recr Board	Adjoining Landowner #1 Edwin Knepp
Address (Street, P.O. Box or Rural Route) P.O. Box 245	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 47553
Adjoining Landowner #2 Rebecca Knepp	Adjoining Landowner #3 Herman Graber
Address (Street, P.O. Box or Rural Route) R.R. 2, Box 145	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 46553
Adjoining Landowner #4 Mark Hopkins	Adjoining Landowner #5 Hubert Hopkins
Address (Street, P.O. Box or Rural Route) R.R. 2	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 47553
Adjoining Landowner #6 Paul Hopkins	Adjoining Landowner #7 Mary Margaret Vineyard
Address (Street, P.O. Box or Rural Route) R.R. 2	Address (Street, P.O. Box or Rural Route) 1707 Chalcdony Street, Apt. 14
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code San Diego, California 92109
Adjoining Landowner #8 Eli Graber	Adjoining Landowner #9 Amos Wagler
Address (Street, P.O. Box or Rural Route) R.R. 2	Address (Street, P.O. Box or Rural Route) R.R. 2
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, Indiana 47553
Adjoining Landowner #10 Norman Wagler	Adjoining Landowner #11 Kenny & Ann Hedrick
Address (Street, P.O. Box or Rural Route) R.R. 2	Address (Street, P.O. Box or Rural Route) R.R. 3
City, state and ZIP code Loogootee, Indiana 47553	City, state and ZIP code Loogootee, IN 47553

7. ADDITIONAL INFORMATION

Corps Public Notice #_____. IDNR Early Coordination #_____

8. STATEMENT OF AFFIRMATION

I hereby swear or affirm, under the penalties for perjury, that the information submitted herewith is to the best of my knowledge and belief, true, accurate and complete, and that the property owner(s) and adjoining landowners have been notified of the project.

NAMES AND ADDRESSES OF THE PROPERTY OWNER AND ADJOINING LANDOWNERS

Provide the name and address of the property owner where the proposed activity will be conducted and list adjoining landowners which may be affected by the proposed project. Use additional sheets if necessary. Failure to list the property owner(s) and each adjoining landowner may cause a permit issued by the Department to later become voided.

Property Owner(s)	Adjoining Landowner #1
Delbert Cengacher	
Address *(Street, P.O. Box or Rural Route)*	Address *(Street, P.O. Box or Rural Route)*
R.R. 2	
City, state and ZIP code	City, state and ZIP code
Loogootee, Indiana 47553	
Adjoining Landowner #2	Adjoining Landowner #3
Address *(Street, P.O. Box or Rural Route)*	Address *(Street, P.O. Box or Rural Route)*
City, state and ZIP code	City, state and ZIP code
Adjoining Landowner #4	Adjoining Landowner #5
Address *(Street, P.O. Box or Rural Route)*	Address *(Street, P.O. Box or Rural Route)*
City, state and ZIP code	City, state and ZIP code
Adjoining Landowner #6	Adjoining Landowner #7
Address *(Street, P.O. Box or Rural Route)*	Address *(Street, P.O. Box or Rural Route)*
City, state and ZIP code	City, state and ZIP code
Adjoining Landowner #8	Adjoining Landowner #9
Address *(Street, P.O. Box or Rural Route)*	Address *(Street, P.O. Box or Rural Route)*
City, state and ZIP code	City, state and ZIP code
Adjoining Landowner #10	Adjoining Landowner #11
Address *(Street, P.O. Box or Rural Route)*	Address *(Street, P.O. Box or Rural Route)*
City, state and ZIP code	City, state and ZIP code

7. ADDITIONAL INFORMATION

Corps Public Notice #_____. IDNR Early Coordination #_____

8. STATEMENT OF AFFIRMATION

I hereby swear or affirm, under the penalties for perjury, that the information submitted herewith is to the best of my knowledge and belief, true, accurate and complete. and that the property owner(s). and adjoining landowners have been notified of the project.

Signature of Applicant or Authorized Representative	Date

PUBLIC NOTICE

August 19, 1993

Davies-Martin County Joint Park & Recr.Board
P.O. Box 245
Loogoote, IN 47553

CERTIFIED MAIL
P 153-604-666

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

Due to your proximity to the project site, you are considered to be an affected party. Therefore, notice is being provided in conformance with the provisions of IC 14-3-16 and 310 IAC 0.6-3:

Applicant's Name and Address:	Davies-Martin County Joint Park and Recreation Board P.O. Box 245 Loogootee, IN 47553
Agent's Name, Address, and Telephone Number:	Commonwealth Engineers, Inc. 7256 Company Drive Indianapolis, IN 46237
Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

"(a) This section established the requirements for a petition to request a public hearing under IC 14-2-16-11 (a)(2).
(b) The petition shall include the signatures of at least twenty-five (25) individuals who are at least eighteen (18) years of age and who reside in the county where the licensed activity would take place or who own real property within one (1) mile of the site of the proposed or existing licensed activity.
(c) The complete mailing addresses of the petitioners shall be typed or printed legibly on the petition.
(d) Each individual who signs the petition shall affirm that the individual qualifies under subsection (b).
(e) The petition shall identify the application for which a public hearing is sought, either by division docket number or by the name of the applicant and the location of the permit."

A pre-AAA hearing on the application will be limited to the Department's authority under the permitting statutes; therefore, discussion which addresses topics beyond the Department's statutory authority may be terminated by the hearing officer.

You may also request that the Department notify you in writing when an initial determination is made to issue or deny the permit. Following the receipt of this post action notice, you may request administrative review of the determination by the Natural Resources Commission under IC 4-21.5 and 310 IAC 0.6-1.

A request for an informal hearing or notice of initial determination should be addressed as follows:

Division of Water
Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Edwin Knepp
R.R. # 2
Loogoote, IN 47553

CERTIFIED MAIL
P 153-604-667

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

Due to your proximity to the project site, you are considered to be an affected party. Therefore, notice is being provided in conformance with the provisions of IC 14-3-16 and 310 IAC 0.6-3:

Applicant's Name and Address:	Davies-Martin County Joint Park and Recreation Board P.O. Box 245 Loogootee, IN 47553
Agent's Name, Address, and Telephone Number:	Commonwealth Engineers, Inc. 7256 Company Drive Indianapolis, IN 46237
Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

"(a) This section established the requirements for a petition to request a public hearing under IC 14-2-16-11 (a)(2).
(b) The petition shall include the signatures of at least twenty-five (25) individuals who are at least eighteen (18) years of age and who reside in the county where the licensed activity would take place or who own real property within one (1) mile of the site of the proposed or existing licensed activity.
(c) The complete mailing addresses of the petitioners shall be typed or printed legibly on the petition.
(d) Each individual who signs the petition shall affirm that the individual qualifies under subsection (b).
(e) The petition shall identify the application for which a public hearing is sought, either by division docket number or by the name of the applicant and the location of the permit."

A pre-AAA hearing on the application will be limited to the Department's authority under the permitting statutes; therefore, discussion which addresses topics beyond the Department's statutory authority may be terminated by the hearing officer.

You may also request that the Department notify you in writing when an initial determination is made to issue or deny the permit. Following the receipt of this post action notice, you may request administrative review of the determination by the Natural Resources Commission under IC 4-21.5 and 310 IAC 0.6-1.

A request for an informal hearing or notice of initial determination should be addressed as follows:

Division of Water
Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Rebbecca Knepp
R.R. # 2 Box 145
Loogoote, IN 47553

CERTIFIED MAIL
P 153-604-668

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

Due to your proximity to the project site, you are considered to be an affected party. Therefore, notice is being provided in conformance with the provisions of IC 14-3-16 and 310 IAC 0.6-3:

Applicant's Name and Address:	Davies-Martin County Joint Park and Recreation Board P.O. Box 245 Loogootee, IN 47553
Agent's Name, Address, and Telephone Number:	Commonwealth Engineers, Inc. 7256 Company Drive Indianapolis, IN 46237
Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

"(a) This section established the requirements for a petition to request a public hearing under IC 14-2-16-11 (a)(2).
(b) The petition shall include the signatures of at least twenty-five (25) individuals who are at least eighteen (18) years of age and who reside in the county where the licensed activity would take place or who own real property within one (1) mile of the site of the proposed or existing licensed activity.
(c) The complete mailing addresses of the petitioners shall be typed or printed legibly on the petition.
(d) Each individual who signs the petition shall affirm that the individual qualifies under subsection (b).
(e) The petition shall identify the application for which a public hearing is sought, either by division docket number or by the name of the applicant and the location of the permit."

A pre-AAA hearing on the application will be limited to the Department's authority under the permitting statutes; therefore, discussion which addresses topics beyond the Department's statutory authority may be terminated by the hearing officer.

You may also request that the Department notify you in writing when an initial determination is made to issue or deny the permit. Following the receipt of this post action notice, you may request administrative review of the determination by the Natural Resources Commission under IC 4-21.5 and 310 IAC 0.6-1.

A request for an informal hearing or notice of initial determination should be addressed as follows:

Division of Water
Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Herman Graber
R.R. # 2
Loogoote, IN 47553

CERTIFIED MAIL
P 153-604-669___

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

Due to your proximity to the project site, you are considered to be an affected party. Therefore, notice is being provided in conformance with the provisions of IC 14-3-16 and 310 IAC 0.6-3:

Applicant's Name and Address:	Davies-Martin County Joint Park and Recreation Board P.O. Box 245 Loogootee, IN 47553
Agent's Name, Address, and Telephone Number:	Commonwealth Engineers, Inc. 7256 Company Drive Indianapolis, IN 46237
Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

"(a) This section established the requirements for a petition to request a public hearing under IC 14-2-16-11 (a)(2).
(b) The petition shall include the signatures of at least twenty-five (25) individuals who are at least eighteen (18) years of age and who reside in the county where the licensed activity would take place or who own real property within one (1) mile of the site of the proposed or existing licensed activity.
(c) The complete mailing addresses of the petitioners shall be typed or printed legibly on the petition.
(d) Each individual who signs the petition shall affirm that the individual qualifies under subsection (b).
(e) The petition shall identify the application for which a public hearing is sought, either by division docket number or by the name of the applicant and the location of the permit."

A pre-AAA hearing on the application will be limited to the Department's authority under the permitting statutes; therefore, discussion which addresses topics beyond the Department's statutory authority may be terminated by the hearing officer.

You may also request that the Department notify you in writing when an initial determination is made to issue or deny the permit. Following the receipt of this post action notice, you may request administrative review of the determination by the Natural Resources Commission under IC 4-21.5 and 310 IAC 0.6-1.

A request for an informal hearing or notice of initial determination should be addressed as follows:

Division of Water
Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Mark Hopkins
R.R. # 2
Loogoote, IN 47553

CERTIFIED MAIL
P 153-604-670

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

Due to your proximity to the project site, you are considered to be an affected party. Therefore, notice is being provided in conformance with the provisions of IC 14-3-16 and 310 IAC 0.6-3:

Applicant's Name and Address:	Davies-Martin County Joint Park and Recreation Board P.O. Box 245 Loogootee, IN 47553
Agent's Name, Address, and Telephone Number:	Commonwealth Engineers, Inc. 7256 Company Drive Indianapolis, IN 46237
Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP. Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

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A pre-AAA hearing on the application will be limited to the Department's authority under the permitting statutes; therefore, discussion which addresses topics beyond the Department's statutory authority may be terminated by the hearing officer.

You may also request that the Department notify you in writing when an initial determination is made to issue or deny the permit. Following the receipt of this post action notice, you may request administrative review of the determination by the Natural Resources Commission under IC 4-21.5 and 310 IAC 0.6-1.

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Telephone: (317)232-4160

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Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Hubert Hopkins
R.R. # 2
Loogoote, IN 47553

CERTIFIED MAIL
P 153-604-671

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

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Agent's Name, Address, and Telephone Number:	Commonwealth Engineers, Inc. 7256 Company Drive Indianapolis, IN 46237
Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

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Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Paul Hopkins
R.R. # 2
Loogoote, IN 47553

CERTIFIED MAIL
P 153-604-672

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

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Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

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A request for an informal hearing or notice of initial determination should be addressed as follows:

Division of Water
Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Mary Margaret Vineyard
1707 Chalcdony St. Apt. 14
San Diego, CA 92109

CERTIFIED MAIL
P 153-604-673

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

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Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

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A request for an informal hearing or notice of initial determination should be addressed as follows:

Division of Water
Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Eli Graber
R.R. # 2
Loogootee, IN 47553

CERTIFIED MAIL
P 153-604-674

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

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Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

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A pre-AAA hearing on the application will be limited to the Department's authority under the permitting statutes; therefore, discussion which addresses topics beyond the Department's statutory authority may be terminated by the hearing officer.

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A request for an informal hearing or notice of initial determination should be addressed as follows:

Division of Water
Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Amos Wagler
R.R. # 2
Loogootee, IN 47553

CERTIFIED MAIL
P 153-604-675

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

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Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

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Department of Natural Resources
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Indianapolis, Indiana 46204-2212

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7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Norman Wagler
R.R. # 2
Loogootee, IN 47553

CERTIFIED MAIL
P 153-604-676

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

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Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
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Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

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Department of Natural Resources
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Indianapolis, Indiana 46204-2212

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Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Kenny and Ann Hedrick
R.R. # 3
Loogootee, IN 47553

CERTIFIED MAIL
P 153-604-677

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

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You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

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Department of Natural Resources
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Indianapolis, Indiana 46237

Telephone: (317)888-1177

PUBLIC NOTICE

August 19, 1993

Delbert Cengacher
R.R. # 3
Loogootee, IN 47553

CERTIFIED MAIL
P 153-604-678

RE: Parcel No.

Legislation has been enacted, IC 14-3-16, which ensures that affected parties are both notified of permit applications and provided with an opportunity to present their views to the Department of Natural Resources prior to action.

The applicant or agent is responsible for providing notice to those persons "adjacent to the affected real property". This term is defined in 310 IAC 0.6-3 as "real property located within one-quarter (¼) mile of the site of an application and owned by a person, other than the applicant, which shares a common border or common point with the exterior boundary of the property where the licensed activity would take place. Included is property which would share a common border if not for the separation caused by a highway, road, or railroad."

Due to your proximity to the project site, you are considered to be an affected party. Therefore, notice is being provided in conformance with the provisions of IC 14-3-16 and 310 IAC 0.6-3:

Applicant's Name and Address:	Davies-Martin County Joint Park and Recreation Board P.O. Box 245 Loogootee, IN 47553
Agent's Name, Address, and Telephone Number:	Commonwealth Engineers, Inc. 7256 Company Drive Indianapolis, IN 46237
Project Location:	SE 1/4 of section 4, T3N, R5W, Barr TWP, Davies County. Approximately 1/2 mile east of County Road 1050 East
Name of Stream or Lake:	West Boggs Lake
Type of Project:	Low head dam Control Structure, Constructed Wetland for sediment and nutrient control
Relevant Statute or Rule :	
Other Information:	This project is to enlarge an esisting wetland

You may request an informal hearing (pre-AAA hearing) on this application by filing a petition with the Director, Division of Water. The petition must be signed by at least 25 individuals who are at least 18 years of age and who either reside in the county where the permitted project would take place or own real property within 1 mile of the site of the proposed or existing permitted project. Additionally, the petition must conform to administrative rule 310 IAC 06.-3-2.3 as follows:

"(a) This section established the requirements for a petition to request a public hearing under IC 14-2-16-11 (a)(2).
(b) The petition shall include the signatures of at least twenty-five (25) individuals who are at least eighteen (18) years of age and who reside in the county where the licensed activity would take place or who own real property within one (1) mile of the site of the proposed or existing licensed activity.
(c) The complete mailing addresses of the petitioners shall be typed or printed legibly on the petition.
(d) Each individual who signs the petition shall affirm that the individual qualifies under subsection (b).
(e) The petition shall identify the application for which a public hearing is sought, either by division docket number or by the name of the applicant and the location of the permit."

A pre-AAA hearing on the application will be limited to the Department's authority under the permitting statutes; therefore, discussion which addresses topics beyond the Department's statutory authority may be terminated by the hearing officer.

You may also request that the Department notify you in writing when an initial determination is made to issue or deny the permit. Following the receipt of this post action notice, you may request administrative review of the determination by the Natural Resources Commission under IC 4-21.5 and 310 IAC 0.6-1.

A request for an informal hearing or notice of initial determination should be addressed as follows:

Division of Water
Department of Natural Resources
402 West Washington Street
Room W264
Indianapolis, Indiana 46204-2212

Telephone: (317)232-4160

Questions relating to the project should be directed to:

Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, Indiana 46237

Telephone: (317)888-1177

DAVIESS-MARTIN COUNTY JOINT PARK AND RECREATION BOARD

WEST BOGGS LAKE ENHANCEMENT DESIGN PROJECT

APPLICATION FOR A SECTION 404 PERMIT AT THE WEST BOGGS LAKE PARK PROPERTY

DECEMBER 1993

COMMONWEALTH ENGINEERS, INC.

APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT
(33 CFR 325)

OMB APPROVAL NO. 0710-0003
Expires 30 September 1992

Public reporting burden for this collection of information is estimated to average 5 hours per response for the majority of cases, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Applications for larger or more complex projects, or those in ecologically sensitive areas, could take up to 500 hours. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Service, Directorate for Information Operations and Projects, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302; and to the Office of Management and Budget, Paperwork Reduction Project (0710-0003), Washington, DC 20503. **Please DO NOT RETURN your completed form to either of these addresses. Completed application must be submitted to the District Engineer having jurisdiction over the location of the proposed activity.**

The Department of the Army permit program is authorized by Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act and Section 103 of the Marine, Protection, Research and Sanctuaries Act. These laws require permits authorizing activities in or affecting navigable waters of the United States, the discharge of dredged or fill material into waters of the United States, and the transportation of dredged material for the purpose of dumping it into ocean waters. Information provided on this form will be used in evaluating the application for a permit. Information in this application is made a matter of public record through issuance of a public notice. Disclosure of the information requested is voluntary; however, the data requested are necessary in order to communicate with the applicant and to evaluate the permit application. If necessary information is not provided, the permit application cannot be processed nor can a permit be issued.

One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

1. APPLICATION NUMBER (To be assigned by Corps)

1993-01-073

2. NAME AND ADDRESS OF APPLICANT

Daviess-Martin County Joint Park & Recreation
West Boggs Park
PO BOX 245
Loogootee, IN 47533

Telephone no. during business hours

A/C ( ) _____ (Residence)
A/C (812) 295-3421 (Office)

3. NAME, ADDRESS, AND TITLE OF AUTHORIZED AGENT

Steve W. Chafin, Environmental Scientist
Commonwealth Engineers, Inc.
7256 Comapny Drive
Indianapolis, IN 46237

Telephone no. during business hours

A/C ( ) _____ (Residence)
A/C (317) 888-1177 (Office)

Statement of Authorization: I hereby designate and authorize Steve W. Chafin to act in my behalf as my agent in the processing of this permit application and to furnish, upon request, supplemental information in support of the application.

SIGNATURE OF APPLICANT

DATE 12/14/93

4. DETAILED DESCRIPTION OF PROPOSED ACTIVITY

4a. ACTIVITY

Installation of approximately 100 linear feet of steel sheet piling driven in an are around the upstream invert of the existing 13.5' X 8.5' pipe arch beneath St. Mary's Road. This will not require earth moving. 62.2 C.Y. of geofabric, rip-rap and grout will also be placed inside the weir and along the road bank for erosion control.

27 C.Y. of limestone shot rock will be dumped in the channel upstream of the weir structure to slow the velocity of incoming flow.

4b. PURPOSE

The proposed construction activity is to raise the water level west of St. Mary's Road, to 502' elevation to increase the area and volume of the existing wetlands to reduce non-point source pollution prior to discharge to West Boggs Lake.

4c. DISCHARGE OF DREDGED OR FILL MATERIAL

The discharge of dredged or fill material is not planned, only the installation of the steel sheet piling weir and associated erosion control measures. The total volume of material placed in this area is 129.2 C.Y. .

5. NAMES AND ADDRESSES OF ADJOINING PROPERTY OWNERS, LESSEES, ETC., WHOSE PROPERTY ALSO ADJOINS THE WATERWAY

The Daviess-Martin County Joint Park Board owns all of the property surrounding the perimeter of the subject waterway with the exception of St. Mary's Road. It is owned by:

Daviess County Board of Commissioners
Courthouse
Washington, IN 47501

6. WATERBODY AND LOCATION ON WATERBODY WHERE ACTIVITY EXISTS OR IS PROPOSED

West Boggs Lake

7. LOCATION ON LAND WHERE ACTIVITY EXISTS OR IS PROPOSED

ADDRESS:

Along the causeway of St. Mary's Road in NE ¼ of section 34, R5W, T4N
STREET, ROAD, ROUTE OR OTHER DESCRIPTIVE LOCATION

Daviess — COUNTY
Indiana — STATE
ZIP CODE

Daviess County Board of Commissioners
LOCAL GOVERNING BODY WITH JURISDICTION OVERSITE

8. Is any portion of the activity for which authorization is sought now complete? ☐ YES ☒ NO
If answer is "yes" give reasons, month and year the activity was completed. Indicate the existing work on the drawings.

9. List all approvals or certifications and denials received from other federal, interstate, state or local agencies for any structures, construction, discharges or other activities described in this application.

ISSUING AGENCY	TYPE APPROVAL	IDENTIFICATION NO.	DATE OF APPLICATION	DATE OF APPROVAL	DATE OF DENIAL

None have been issued

10. Application is hereby made for a permit or permits to authorize the activities described herein. I certify that I am familiar with the information contained in the application, and that to the best of my knowledge and belief such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities or I am acting as the duly authorized agent of the applicant.

Robert E. Schmidt — SIGNATURE OF APPLICANT
12/14/93 — DATE
Steven W. Cashin — SIGNATURE OF AGENT
12/9/93 — DATE

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 3 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of The United States knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.

*U.S. Government Printing Office: 1991 — 526-235/4

APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT
(33 CFR 325)

OMB APPROVAL NO. 0710-0003
Expires 30 September 1992

Public reporting burden for this collection of information is estimated to average 5 hours per response for the majority of cases, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Applications for larger or more complex projects, or those in ecologically sensitive areas, could take up to 500 hours. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Service, Directorate for Information Operations and Projects, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302; and to the Office of Management and Budget, Paperwork Reduction Project (0710-0003), Washington, DC 20503. Please DO NOT RETURN your completed form to either of these addresses. Completed application must be submitted to the District Engineer having jurisdiction over the location of the proposed activity.

The Department of the Army permit program is authorized by Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act and Section 103 of the Marine, Protection, Research and Sanctuaries Act. These laws require permits authorizing activities in or affecting navigable waters of the United States, the discharge of dredged or fill material into waters of the United States, and the transportation of dredged material for the purpose of dumping it into ocean waters. Information provided on this form will be used in evaluating the application for a permit. Information in this application is made a matter of public record through issuance of a public notice. Disclosure of the information requested is voluntary; however, the data requested are necessary in order to communicate with the applicant and to evaluate the permit application. If necessary information is not provided, the permit application cannot be processed nor can a permit be issued.

One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

1. APPLICATION NUMBER (To be assigned by Corps)

1993-01-075

2. NAME AND ADDRESS OF APPLICANT
Daviess-Martin County Joint Park & Recreation Board
West Boggs Park
P.O. Box 245
Loogootee, IN 47553

Telephone no. during business hours

A/C ( ) _____ (Residence)
A/C (812) 295-3421 (Office)

3. NAME, ADDRESS, AND TITLE OF AUTHORIZED AGENT
Steve W. Chafin, Environmental Scientist
Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, IN 46237
Telephone no. during business hours

A/C ( ) _____ (Residence)
A/C (317) 888-1177 (Office)

Statement of Authorization: I hereby designate and authorize Steve W. Chafin to act in my behalf as my agent in the processing of this permit application and to furnish, upon request, supplemental information in support of the application.

SIGNATURE OF APPLICANT: Robert E. Kuntz
DATE: 12/14/93

4. DETAILED DESCRIPTION OF PROPOSED ACTIVITY

4a. ACTIVITY
Installation of a steel sheet piling weir and associated erosion control measures. The sheet piling dam will be approximately 625 Feet long. At each of three outlet structures and on the slopes at either end of the weir 56.2 C.Y. pf geofabric and rip-rap will be installed. Upstream of the weir 36.2 C.Y. of shot rock will be dumped in the incoming channel to reduce flow velocity.

4b. PURPOSE
The weir is designed to increase the normal pool elevation of the existing wetland from 499.6 feet to 501.3 feet, to facilitate sediment fallout and nutrient uptake from the water prior to its discharge to West Boggs Lake. The rip-rap and geofabric are for erosion control in high energy areas.

4c. DISCHARGE OF DREDGED OR FILL MATERIAL
The primary fill materials will be steel sheet piling and limestone rip-rap. The total steel to be installed is 170 C.Y. . The total stone and geofabric installed is 92.4 C.Y..

5. NAMES AND ADDRESSES OF ADJOINING PROPERTY OWNERS, LESSEES, ETC., WHOSE PROPERTY ALSO ADJOINS THE WATERWAY

The Daviess-Martin Park Board owns all of the property surrounding West Boggs Lake, including the proposal site, with the exception of C.R. 1050 E which is owned by: The Daviess County BOard of Commissioners
Courthouse
Washington, IN 47501

6. WATERBODY AND LOCATION ON WATERBODY WHERE ACTIVITY EXISTS OR IS PROPOSED

West Boggs Lake

7. LOCATION ON LAND WHERE ACTIVITY EXISTS OR IS PROPOSED

ADDRESS:

East of C.R. 1050 E in the SE ¼ of Section 4, T 3N, R5W
STREET, ROAD, ROUTE OR OTHER DESCRIPTIVE LOCATION

Daviess (COUNTY) Indiana (STATE) 47501 (ZIP CODE)

Daviess County COmmissioners
LOCAL GOVERNING BODY WITH JURISDICTION OVERSITE

Is any portion of the activity for which authorization is sought now complete? ☐ YES ☒ NO
If answer is "yes" give reasons, month and year the activity was completed. Indicate the existing work on the drawings.

List all approvals or certifications and denials received from other federal, interstate, state or local agencies for any structures, construction, discharges or other activities described in this application.

ISSUING AGENCY	TYPE APPROVAL	IDENTIFICATION NO.	DATE OF APPLICATION	DATE OF APPROVAL	DATE OF DENIAL

None have been issued

10. Application is hereby made for a permit or permits to authorize the activities described herein. I certify that I am familiar with the information contained in the application, and that to the best of my knowledge and belief such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities or I am acting as the duly authorized agent of the applicant.

SIGNATURE OF APPLICANT — DATE: 12/14/93

SIGNATURE OF AGENT — DATE: 12/9/93

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 3 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of The United States knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.

*U.S. Government Printing Office: 1991 — 526-235/4

December 8, 1993

To: **Attention: Mr. Gerry Newell**
U.S. Army Corps of Engineers
P.O. Box 59
Louisville, KY 40201-0059

From: Steve W. Chafin, Environmental Scientist
Commonwealth Engineers, Inc.
7256 Company Drive
Indianapolis, IN 46237

Acting as agent of the following applicant:

Daviess-Martin County Joint Park and Recreation Board
West Boggs Park
P.O. Box 245
Loogootee, IN 47553

Subject: Section 404 permitting for the West Boggs Lake Enhancement Project

Dear Mr. Newell:

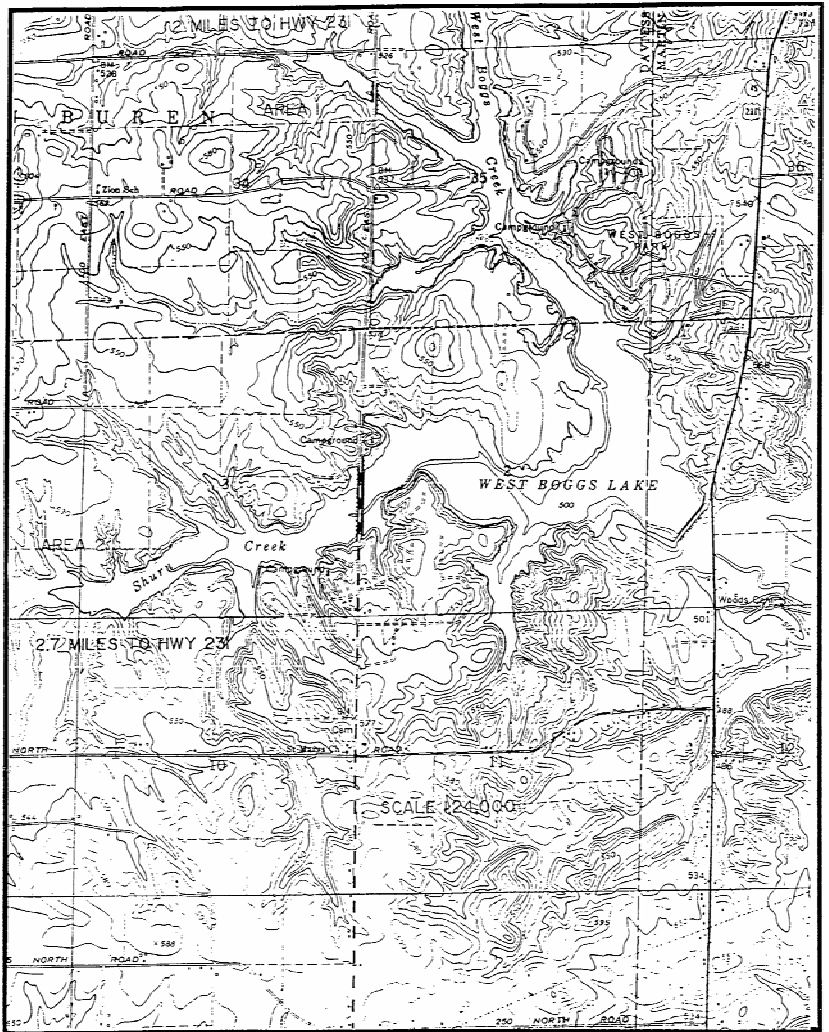
In response to a request by the Daviess-Martin County Joint Park and Recreation Board, and the Indiana Department of Natural Resources, Commonwealth Engineers, Inc. (CEI) staff have completed an assessment of the wetlands located on the two subject sites described below. It was determined that the two areas that are the subject of this investigation are indeed jurisdictional wetlands. The subject wetlands are contiguous with the West Boggs Lake ecosystem. The approximate locations of the wetlands are illustrated on the 1'=400' base maps shown on Drawings 4 and 5. These approximate boundaries have been located on the map using information from the field as well as from 1"=50' scale, one (1) foot contour interval topographic maps developed as part of this project.

LOCATION

Both areas 1 and 2 are found on the U.S. Department of Interior, Loogootee, IN Quadrangle (see Drawing 1). Each area is a tributary to West Boggs Lake.

Area 1, an unnamed creek arm of West Boggs Lake, is located in Sections 27 and 34, Township 4 North, Range 5 West, of eastern Daviess County. It is the area on the west side of the St. Mary's Road causeway.

Area 2 is the Shurn Creek arm of West Boggs Lake, located in Sections 3 and 4, Township 3 North, Range 5 West of eastern Daviess County. This is in the southwest arm of the lake.



COMMONWEALTH ENGINEERS, INC.

TITLE: LOCATION MAP		APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD	
LOCATION: AREA 1 & 2		NEAR: LOOGOOTEE, INDIANA	
COUNTY: DAVIESS COUNTY	DATE: 12/93	SCALE:	DWG. NO.: 1 OF 13

GENERAL SITE CHARACTERISTICS and PROJECT BACKGROUND

West Boggs Lake, located approximately 3 miles north of Loogootee, Indiana, was impounded in 1971. The lake was originally designed to have a surface area of 622 acres, but now has less than 575 acres due to sedimentation. The watershed is predominantly in intensive agricultural land use with 90% of the soils in the watershed classified as being highly erodible. This has resulted in the rapid filling of the lake and associated degradation from the eutrophication process.

The Daviess-Martin County Joint Park and Recreation Board, in conjunction with the Indiana Department of Natural Resources', Division of Soil Conservation and the Daviess County SWCD, is sponsoring a lake enhancement project for West Boggs Lake. The primary objectives of this project are to reduce sediment and nutrient loading from sources within the watershed using a variety of best management practices and two structural controls (which are the subjects of this permit application). Secondary objectives of this project are to preserve the existing lake volume, increase the storage volume in the watershed, and provide increased wildlife habitat area.

The structural elements of the project are designed to control the hydrology of two existing wetlands to increase the depth and area of water in the two project sites. Each of the construction sites is located within jurisdictional wetland areas that are a part of the West Boggs Lake ecosystem. The structural elements of the wetland development in each area are the subject of the permit application.

Area 1

The existing wetland system in Area 1 is composed of an intermittent stream entering a palustrine forested wetland with saturated soils then merging into a palustrine emergent wetland with saturated to inundated soils downstream. Further downstream is a palustrine unconsolidated bottom wetland perennially inundated. The wetland in Area 1 is connected to the main body of West Boggs Lake, on the east side of St. Mary's Road, via a 13.5' x 8.5' corrugated, galvanized pipe arch. The area around the upstream end of the pipe arch is the proposed construction site for a steel sheet piling weir described in detail later in this report.

Area 2

The existing wetland system in Area 2 is also composed of an intermittent stream entering a palustrine forested wetland with saturated soil, which merges into a palustrine emergent wetland downstream with saturated to inundated soil, which progresses to a lacustrine unconsolidated bottom wetland. The proposed construction site at this area is approximately at the ecotone between the PEM/LUB wetlands.

In the opinion of CEI staff, the habitat value of the wetlands are considered relatively high in both areas. This opinion is based on the following observations and characteristics of the sites: the sites are a component of the larger West Boggs Lake aquatic ecosystem; except for the heavy sedimentation, the habitat is relatively undisturbed by human activity since it is managed by the Park Board; there is abundant evidence of the wetlands being used by a variety of wildlife species. However, after the projects are complete, wetland habitat area will be significantly increased.

PROPOSED ACTIVITY

The purpose of the proposed activity is to increase the area and volume of the existing wetlands at each proposed construction site. This is to increase their effectiveness at removing sediment and nutrients transported in runoff from the watershed before the water enters West Boggs Lake.

Area 1

The project planned in Area 1 consists of the following fill activities:

1) Placing a steel sheet piling weir structure, with an adjustable stop plank outlet in each side wall, structure immediately upstream of the upstream invert of the existing 13.5' x 8.5' pipe arch. This is to raise the normal pool elevation upstream of the pipe arch (west side) beneath St Mary's Road causeway by 2.4 feet to 502 feet from the present 499.6 feet. A geofabric beneath rip-rap armour will be used in high energy areas to prevent erosion.

   The volume of the steel sheet piling is 40 cubic yards. The wetland area to be occupied by the steel sheet piling weir in Area 1 is 58.5 square feet or 0.0013 acres.

   The volume of rip-rap to be placed within the bottom of the weir structure, along the road bed within the weir area, and along the road at either end of the structure outside the weir amounts to 62.2 cubic yards covering 0.033 acres.

2) Placement of 27 cubic yards of dumped shot rock (first blast stones of approximately 250 pounds each), covering 0.014 acres, in the creek channel to obstruct channelized flow for reducing velocity and to more evenly distribute flow over the wetland system, thus maximizing retention time and wetland system contact.

   See Drawings 6, 7, 8, and 9 for Area 1 construction plans.

Area 2

The project planned in this area consists of fill activities described as follows:

1) In Area 2, where Shurn Creek enters West Boggs Lake, a steel sheet piling weir is planned for construction to increase the size and volume of the existing wetland.

   The proposed dam will stretch completely across is the Shurn Creek bottom and will have stop plank outlet structures capable of completely draining the wetland areas upstream of the proposed dam for periodic maintenance.

   The steel sheeting will have a volume of 170 cubic yards and cover an area of 307 square feet or .007 acres.

   The top of the dam will be set at 501.3 feet above the existing normal water pool elevation of 499.6 feet above mean sea level.

   Geofabric and rip-rap will be placed on side slopes at either end of the weir to prevent erosion. Rip-rap will also be placed on the downstream side of each stop log opening to prevent erosion from current when stop logs are removed.

   The volume of rip-rap placed in the Area 2 wetlands for erosion control is 56.2 cubic yards. The amount of area covered by the rip-rap will be 1,200 square feet, or 0.0275 acres.

2) To slow the velocity of incoming water and encourage even water distribution throughout the proposed wetland, dumped shot rock will be placed in the Shurn Creek channel at the location indicated in Drawing 10.

   The volume of shot rock to be dumped in the channel is 36.2 cubic yards. The shot rock will occupy 780 square feet of area, or 0.018 acres.

   See Drawings 10, 11, 12, and 13 for Area 2 preliminary construction plans.

NATIONAL WETLANDS INVENTORY

The National Wetlands Inventory (NWI) for the Loogootee, IN Quadrangle (1987) indicates the presence of wetlands on the subject sites. The NWI serves only as a large scale guide, however, and the actual wetland boundaries often vary.

In Area 1, the following wetland types are noted following the U.S. Fish & Wildlife wetland classification system (from Cowardin 1979).

PUBGh = Palustrine Unconsolidated Bottom

PFO1Ah = Palustrine Forested

PEMCh = Palustrine Emergent

In Area 2, the following wetland types are noted following the U.S. Fish & Wildlife Service's wetland classification system (from Cowardin 1979).

PFO1Ah = Palustrine Forested

PEMCh = Palustrine Emergent

PSS1Ch = Palustrine Scrub-Shrub

The above mentioned wetlands are present at the subject sites.

WETLAND DELINEATION

The areas proposed for construction activity are indeed jurisdictional wetlands. The construction sites are either inundated or saturated with water for most of the year. The entire project will be carried out in jurisdictional wetlands. However, given the nature of the projects, it is necessary to place the structures in these locations. There are no alternative sites in upland area where weir structures can be placed.

Since the proposed activity is to enlarge and create wetlands rather than to replace wetlands with urban or upland land uses, a detailed field boundary delineation was deemed unnecessary for this project. Therefore, data from only three sample plots in each area were recorded. The approximate boundaries have been superimposed on the 1"=400' base maps in Drawings 4 and 5.

On March 31, 1993, Commonwealth Engineers, Inc. (CEI) staff performed a wetlands field investigation of the subject sites. The aforementioned Drawings and information

were used in conjunction with an inventory of the dominant plants in the subject sites to determine that the sites are jurisdictional wetlands.

The January 1987 Corps of Engineers Wetlands Delineation Manual, identifies the mandatory technical criteria for wetland identification. The three essential characteristics of a jurisdictional wetland are hydrophytic vegetation, hydric soils and wetland hydrology.

The hydrophytic vegetation criterion is based on a separation of plants into four basic groups:

(1) obligate wetland plants (OBL) that occur almost always (estimated probability >99%) in wetlands under natural conditions;

(2) facultative wetland plants (FACW) that usually occur in wetlands (estimated probability 67-99%), but occasionally are found in nonwetlands;

(3) facultative plants (FAC) that are equally likely to occur in wetlands or nonwetlands (estimated probability 34-66%); and

(4) facultative upland plants (FACU) that usually occur in nonwetlands (estimated probability 67-99%), but are occasionally found in wetlands (estimated probability 1-33%).

If a species occurs almost always (estimated probability >99%) in nonwetlands under natural conditions, it is considered an obligate upland plant (UPL). If greater than 50% of the plants present are FAC, FACW, or OBL the subject area is considered jurisdictional in terms of vegetation.

Hydric soils are defined in the manual as "soils that are saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions in the upper part". Field indicators include color, mottling, gleying, odor, wetness, and the predominance of hydrophytic vegetation present in the soil.

The wetland hydrology criterion is often the most difficult to determine. Typically, the presence of water for a week or more during the growing season creates anaerobic conditions in the soil. Anaerobic conditions lead to the prevalence of wetland plants, and indicative soil characteristics. Morphological adaptations of plants, driftlines, and water marks are examples of wetland hydrology field indicators.

Refer to the following Data Sheets for field notes on the existing wetland conditions in Areas 1 and 2.

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: Daviess-Martin County Joint Park & Rec. Board
Application Number: 1993-01-073
Project Name: Lake Enhancement Design Phase

State: IN County: Daviess Legal Description: Township: 4N Range: 5W
Date: 3/31/93 Plot No.: Area 1, Plot 1 Section: 34

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		Herbs	
1. Platanus Occidentalis	FACW	7. Typha Latifolia	OBL
2. Betula Nigra	FACW	8.	
3. Quercus Palustris	FACW	9.	
Saplings/Shrubs		Woody Vines	
4.		10.	
5.		11.	
6.		12.	

% of species that are OBL, FACW and/or FAC: 100%. Other indicators: _____.
Hydrophytic vegetation: YES X NO ___. Basis: >50% of dominant species are hydrophytic

Soil
Series and phase: Stendal (Sr) On hydric soils list? YES X ; NO ___.
Mottled: YES X ; NO ___. Mottle color: 10 Yr 6/1; Matrix color: 10 Yr 5/2.
Gleyed: YES X ; NO ___ Other indicators: saturated/acidic.
Hydric soils: YES X ; NO ___; Basis: saturation, hydric characteristics.

Hydrology
Inundated: YES ___; NO X . Depth of standing water: _____.
Saturated soils: YES X ; NO ___. Depth to saturated soil: <6" .
Other indicators: predominance of hydrophytes, morphological, adaptations.
Wetland hydrology: YES X ; NO ___. Basis: abundant evidence of wetland hydrology.
Atypical situation: YES ___; NO X .
Normal Circumstances? YES X ; NO ___.
Wetland Determination: Wetland yes ; Nonwetland _____.
Comments:

Determined by: Steps 4-12

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: Daviess-Martin County Joint Park & Rec. Board
Application Number: 1993-01-073
Project Name: Lake Enhancement Design

State: IN County: Daviess Legal Description: Township: 4N Range: 5W
Date: 3/31/93 Plot No.: Area 1, Plot 2 Section: 34

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		Herbs	
1.		7. Typha Latifolia	OBL
2.		8.	
3.		9.	
Saplings/Shrubs		Woody Vines	
4. Salix Nigra	OBL	10.	
5.		11.	
6.		12.	

% of species that are OBL, FACW and/or FAC: 100%. Other indicators: _____.
Hydrophytic vegetation: YES X NO___. Basis: Predominance of OBL hydrophytes

Soil
Series and phase: Stendal (Sr) On hydric soils list? YES X; NO___.
Mottled: YES X; NO___. Mottle color: 10 Yr 6/1; Matrix color: 10 Yr 5/2.
Gleyed: YES X; NO___ Other indicators: strong hydrogen sulfide odor.
Hydric soils: YES X; NO___; Basis: Possesses hydric characteristics.

Hydrology
Inundated: YES X; NO___. Depth of standing water: 0-3"_____.
Saturated soils: YES X; NO___. Depth to saturated soil: 0"___.
Other indicators: predominance of hydrophytic vegetation.
Wetland hydrology: YES X; NO___. Basis: inundated soils.
Atypical situation: YES___; NO X.
Normal Circumstances? YES X; NO___.
Wetland Determination: Wetland yes ____; Nonwetland_____.
Comments:

Determined by: Steps 4-12

Area 1
Data Sheet 2

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: Daviess-Martin County Joint Park & Rec. Board
Application Number: 1993-01-073
Project Name: Lake Enhancement Design Phase

State: IN County: Daviess Legal Description: Township: 4N Range: 5W
Date: 3/31/93 Plot No.: Area 1, Plot 3 Section: 34

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		Herbs	
1.		7	
2.		8.	
3.		9.	
Saplings/Shrubs		Woody Vines	
4.		10.	
5.		11.	
6.		12.	

% of species that are OBL, FACW and/or FAC:___. Other indicators:_____.
Hydrophytic vegetation: YES___ NO_X_. Basis: No rooted vegetation present

Soil
Series and phase: Stendal (Sr) On hydric soils list? YES_X_; NO___.
Mottled: YES___; NO___. Mottle color:_____; Matrix color:_____.
Gleyed: YES___; NO___ Other indicators:_____.
Hydric soils: YES_X_; NO___; Basis: inundated perennially.

Hydrology
Inundated: YES_X_; NO___. Depth of standing water: <3.5'_____.
Saturated soils: YES_X_; NO___. Depth to saturated soil:_____.
Other indicators: water marks on bank proves permanent flooding.
Wetland hydrology: YES_X_; NO___. Basis: perennial free standing water.
Atypical situation: YES___; NO_X_.
Normal Circumstances? YES_X_; NO___.
Wetland Determination: Wetland_yes_____; Nonwetland_____.
Comments: There current is no rooted vegetation on the site due to the extremely high turbidity of the water, no light penetrates to the substrate.

Determined by: Steps 4-12

Area 1
Data Sheet 3

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: Daviess-Martin County Joint Park & Rec. Board
Application Number: 1993-01-015
Project Name: Lake Enhancement Design Phase

State: IN County: Daviess Legal Description: Township: 3N Range: 5W
Date: 3/31/93 Plot No.: Area 2, Plot 1 Section: 4

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		Herbs	
1. Acer Rubra	FAC	7.	
2. Quercus Imbricaria	FAC	8.	
3. Fraxinus Nigra	FACW	9.	
Saplings/Shrubs		Woody Vines	
4. Acer Rubra	FAC	10.	
5.		11.	
6.		12.	

% of species that are OBL, FACW and/or FAC: 75%. Other indicators: _____.
Hydrophytic vegetation: YES X NO___. Basis: Based on Region 3 hydrophitic vegetation list.

Soil
Series and phase: Cuba (Cu) On hydric soils list? YES___; NO X .
Mottled: YES X ; NO___. Mottle color: 10 Yr 6/6; Matrix color: 10 Yr 4/2.
Gleyed: YES___; NO X Other indicators:_____.
Hydric soils: YES___; NO X ; Basis: Does not possess hydric characteristics.

Hydrology
Inundated: YES___; NO X . Depth of standing water:_____.
Saturated soils: YES X ; NO___. Depth to saturated soil: 16"___.
Other indicators:_____.
Wetland hydrology: YES___; NO X . Basis: Soil was not _____.
Atypical situation: YES___; NO___.
Normal Circumstances? YES X ; NO___.
Wetland Determination: Wetland_____; Nonwetland X _____.
Comments: This is the upland edge just west of the wetland system.

Determined by: Steps 4-12

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: Joint Park & Rec. Board
Application Number: 1993-01-015
Project Name: Lake Enhancement Design Phase

State: IN County: Daviess Legal Description: Township: 3N Range: 5W
Date: 3/31/93 Plot No.: Area 2, Plot 2 Section: 4

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		Herbs	
1. Acer Rubra	FAC	7.	
2. Fraxinus Nigra	FACW	8.	
3. Platanus Occidentalis	FACW	9.	
Saplings/Shrubs		Woody Vines	
4.		10. Rosa Palustris	OBL
5.		11.	
6.		12.	

% of species that are OBL, FACW and/or FAC: 100%. Other indicators: _____.
Hydrophytic vegetation: YES X NO ___. Basis: Based on Region 3 hydrophitic vegetation list.

Soil
Series and phase: Cuba (Cu) On hydric soils list? YES ___; NO X .
Mottled: YES X ; NO ___. Mottle color: 10 Yr 5/2; Matrix color: 10 Yr 4/2.
Gleyed: YES X ; NO ___ Other indicators: Saturation ___.
Hydric soils: YES X ; NO ___; Basis: Possesses hydric characteristics.

Hydrology
Inundated: YES ___; NO X . Depth of standing water: _____.
Saturated soils: YES X ; NO ___. Depth to saturated soil: <8" ___.
Other indicators: Predominance of hydrophytes _____.
Wetland hydrology: YES X ; NO ___. Basis: Soil saturation _____.
Atypical situation: YES ___; NO X .
Normal Circumstances? YES X ; NO ___.
Wetland Determination: Wetland Yes ; Nonwetland _____.
Comments: Shurn Creek channel has natural levees on either bank that are slightly higher than the ground over 25 feet beyond the channel banks; in the lower places are palustrine wetlands.

Determined by: Steps 4-12

Area 2
Data Sheet 2

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: Daviess-Martin County Joint Park & Rec. Board
Application Number: 1993-01-015
Project Name: Lake Enhancement Design Phase

State: IN County: Daviess Legal Description: Township: 3N Range: 5W
Date: 3/31/93 Plot No.: Area 2, Plot 3 Section: 4

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		Herbs	
1. Fraxinus Nigra	FACW	7. Equisetum Hymetale	FACW
2. Platanus Occidentalis	FACW	8. Typha Latifolia	OBL
3. Salix Nigra	OBL	9.	
Saplings/Shrubs		Woody Vines	
4.		10. Rosa Palustris	OBL
5.		11.	
6.		12.	

% of species that are OBL, FACW and/or FAC: 100%. Other indicators: _____.
Hydrophytic vegetation: YES X NO ___. Basis: _____.

Soil
Series and phase: Cuba (Cu) On hydric soils list? YES ___; NO X .
Mottled: YES X ; NO ___. Mottle color: 10 Yr 5/1; Matrix color: 10 Yr 3/2.
Gleyed: YES X ; NO ___ Other indicators: Saturated .
Hydric soils: YES ___; NO ___; Basis: _____.

Hydrology
Inundated: YES ___; NO X . Depth of standing water: _____.
Saturated soils: YES X ; NO ___. Depth to saturated soil: <3" .
Other indicators: Evidence of periodic inundation .
Wetland hydrology: YES X ; NO ___. Basis: _____.
Atypical situation: YES ___; NO X .
Normal Circumstances? YES X ; NO ___.
Wetland Determination: Wetland Yes ; Nonwetland _____.
Comments:

Determined by: Steps 4-12

SOILS

The 1974 Daviess County Soil Survey, as shown in Drawings 2 and 3 (Sheet No. 16 for Area 1 and Sheet number 20 for Area 2) was consulted to help determine the presence of hydric soil on the site. Mapped hydric soils are often indicative of wetland conditions. The soil mapping units indicated, by the soil survey, to be present on the property are:

In Area 1

Sr = Stendal Silt Loam - Hydric

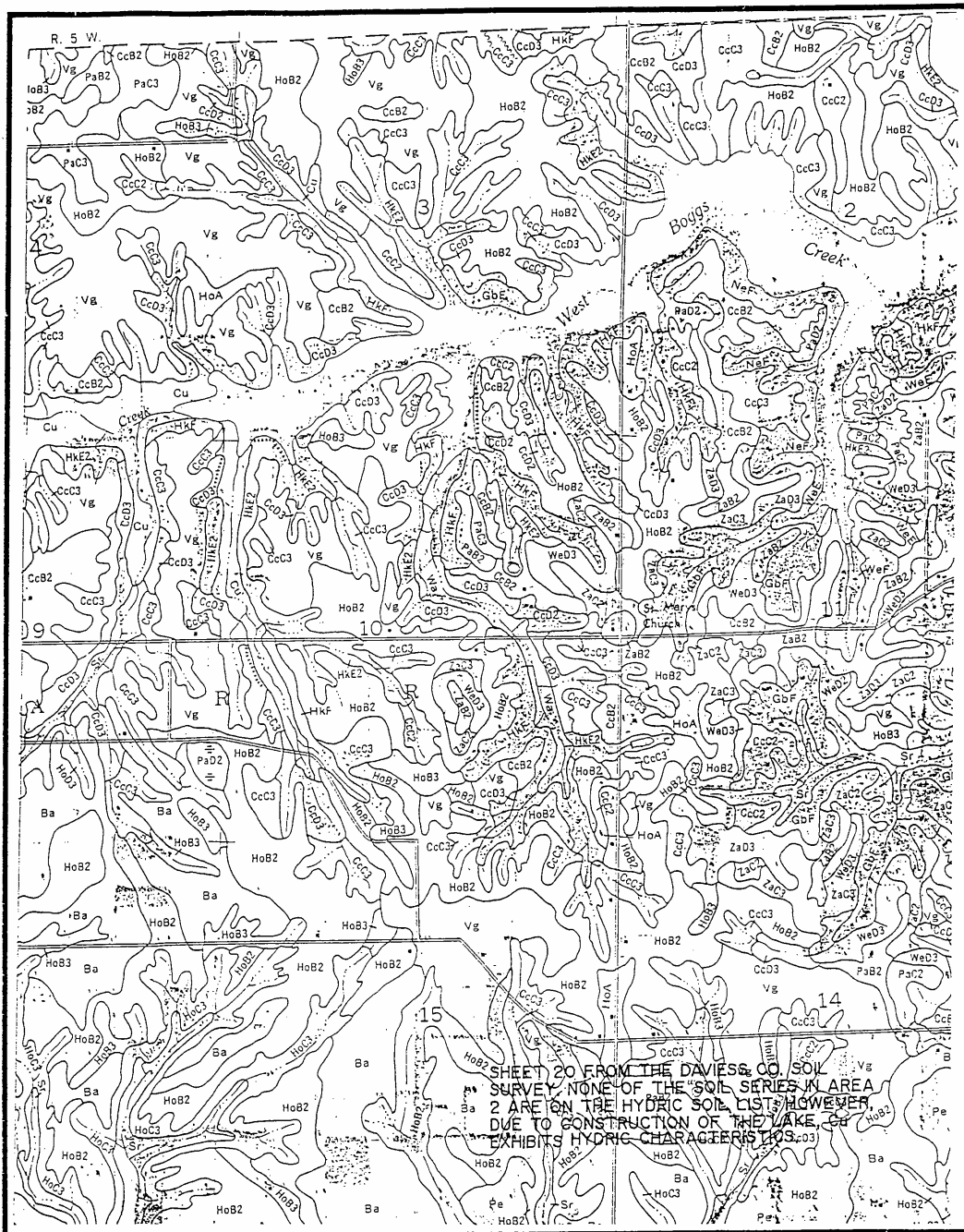
In Area 2

Cu = Cuba Silt Loam - Non-Hydric

Due to the alteration of the local hydrology by construction of the lake, the Cuba soil of Area 2 is now sufficiently wet to support a predominance of hydrophytic vegetation and to have hydric soil conditions.

COMMONWEALTH ENGINEERS, INC. 16

TITLE: DAVIESS COUNTY SOIL SURVEY	APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD
LOCATION: AREA 1	NEAR: LOOGOOTEE, INDIANA
COUNTY: DAVIESS COUNTY	DATE: 12/83
SCALE:	DWG. NO.: 2 OF 13



SHEET 20 FROM THE DAVIESS CO. SOIL SURVEY. NONE OF THE SOIL SERIES IN AREA 2 ARE ON THE HYDRIC SOIL LIST. HOWEVER, DUE TO CONSTRUCTION OF THE LAKE, CU EXHIBITS HYDRIC CHARACTERISTICS.

COMMONWEALTH ENGINEERS, INC.

TITLE: DAVIESS COUNTY SOIL SURVEY	APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD
LOCATION: AREA 2	NEAR: LOOGOOTEE, INDIANA
COUNTY: DAVIESS COUNTY	DATE: 12/93
SCALE:	DWG. NO.: 3 OF 13

HYDROPHYTIC VEGETATION

As the field investigation Data Sheets indicate, the wetlands in Area 1 are primarily composed of a palustrine wetland dominated by hydrophytic trees and shrubs around the wetland margins, which merges into emergent herbaceous cover (cattails), which further merges into open water averaging 2.5 feet deep near the St. Mary's Road causeway. Due to the turbidity of the water in Area 1, no rooted macrophytes are present in the proposed construction site.

The proposed construction site in Area 2 is approximately where, at existing normal pool (499.6'), the free water surface meets the land. A variety of obligate emergents and facultative wetland plants are located at the proposed Area 2 construction site. To minimize the disturbance of this community steel sheet piling will be used. This material allows construction without heavy earth moving activity.

WETLAND HYDROLOGY

For an area to possess wetland hydrology, the soil must be inundated or saturated to the surface at some time during the growing season. Evidence of wetland hydrology includes areas where the presence of water has an overriding influence on the vegetation and soil characteristics due to anaerobic and reducing conditions, respectively.

The proposed Area 1 construction site is perennially inundated with the exception of periodic reservoir drawdowns.

The proposed construction site in Area 2 is perennially saturated and inundated with water for most of the year.

PROPOSED MITIGATION

Given the design of the proposed weir structures (i.e., steel sheet piling), a minimum of wetland area will receive fill material to construct the weirs. Drawings 6 through 13 illustrate the proposed construction activity, and detail the volumes of materials that will be placed in the wetlands.

To mitigate for the functional values lost by placing fill material in the existing wetlands described above, approximately 21.5 total acres of new wetlands are planned to be developed as a result of this construction activity. The Area 1 wetland will be enlarged from approximately 11 acres to an approximate planned 17.5 acres. Area 2 will be enlarged from an estimated 30 existing acres to approximately 45 acres.

CONCLUSION

Under current guidelines and in accordance with customary practices of the COE, any wetland greater than one acre in size will require a permit to be altered in conjunction with mitigation to prevent any net loss of total wetland area. Areas of wetland less than one acre in size also require a permit to be dredged or filled; however, mitigation may or may not be required depending upon COE discretion.

Area 1 was determined to have approximately 11 acres of jurisdictional wetlands based on the methodology established by the U. S. Army Corps of Engineers. Of this, only 0.056 acre of wetland will be replaced by construction of the weir. Approximately 6.5 additional acres of wetland are planned to be developed as a result of this flow modification structure.

Area 2 was determined to have approximately 30 acres of jurisdictional wetlands based on the methodology established by the U. S. Army Corps of Engineers. Of this, only 0.053 acre of wetland will be replaced by construction of the weir. Approximately 15 additional acres of wetland are planned to be developed as a result of this dam.

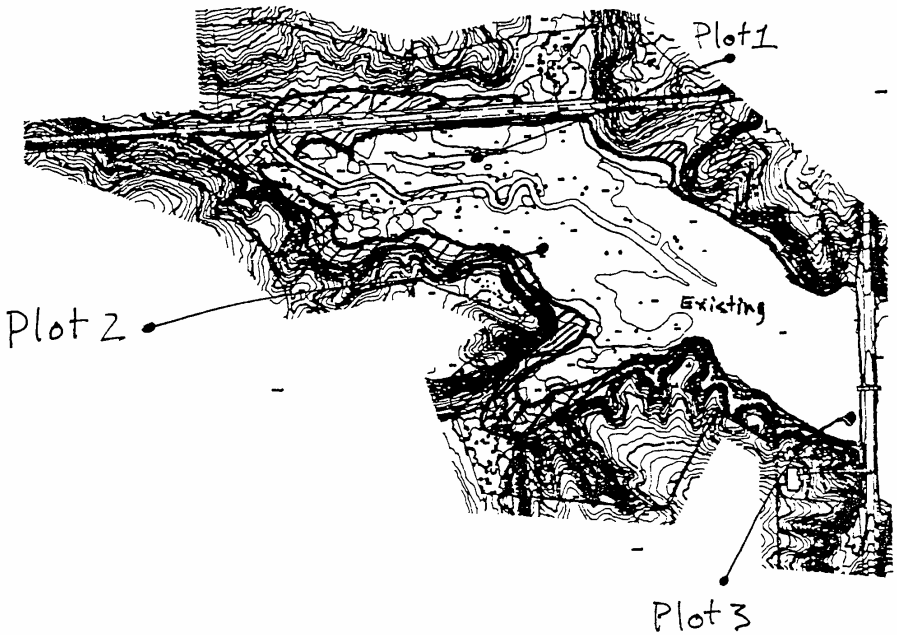
If the Daviess-Martin County Joint Park and Recreation Board were not granted a Corps of Engineers permit to conduct this activity the lake will continue to fill in and lose volume as a result of the deposition of sediment being transported from the watershed. Also, both dissolved nutrients and sediment associated nutrients will continue to enter the lake, further worsening the eutrophic condition of West Boggs Lake.

It is the understanding of CEI that the construction activity in each area will require an individual permit. If you have any questions or comments, please do not hesitate to call me at (317) 888-1177.

Respectfully Submitted,

Steve W. Chafin
Environmental Scientist

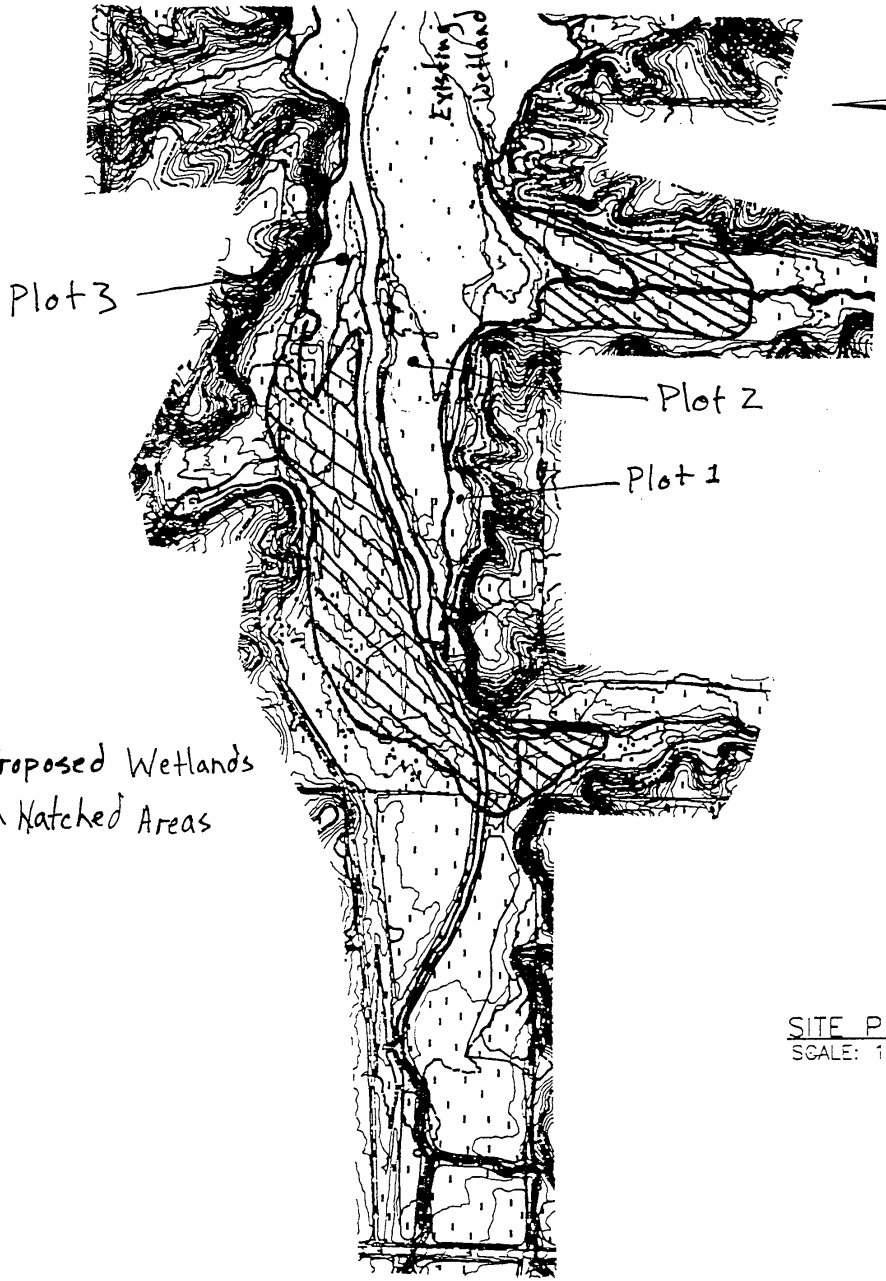
Proposed Wetlands in Hatched Areas



SITE PLAN
SCALE: 1" =400'

COMMONWEALTH ENGINEERS, INC.

TITLE: EXISTING AND PROPOSED WETLANDS		APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOAR	
LOCATION: AREA 1		NEAR: LOOGOOTEE, INDIANA	
COUNTY: DAVIESS COUNTY	DATE: 12/93	SCALE: 1"=400'	DWG. NO.: 4 OF



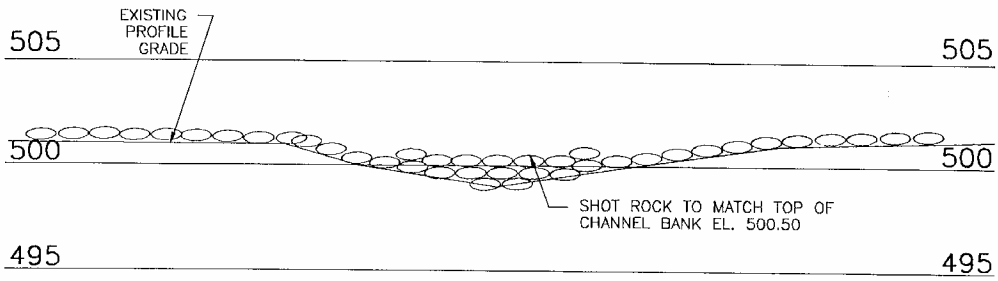
SITE PLAN
SCALE: 1" =400'

COMMONWEALTH ENGINEERS, INC.

TITLE: EXISTING AND PROPOSED WETLANDS		APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD	
LOCATION: AREA 2		NEAR: LOOGOOTEE, INDIANA	
COUNTY: DAVIESS COUNTY	DATE: 12/93	SCALE: 1"=400'	DWG. NO.: 5 OF 13

COMMONWEALTH ENGINEERS, INC.

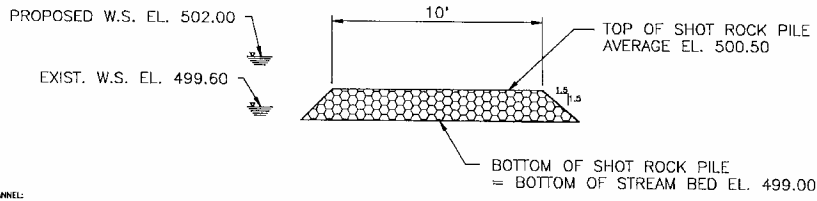
TITLE: CHANNEL FLOW DIVERSION STRUCTURE - RUM	APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD
LOCATION: AREA 1	LOGOOTEE, INDIANA
COUNTY: DAVIESS COUNTY	DATE: 12/93
SCALE: 1"=50'-0"	DWG. NO.: 6 OF 13



PROFILE

SCALE: 1"=5' HORIZ.
1"=5' VERT.

NOTE:
CONTINUE RIP-RAP 15' ON BOTH SIDES OF BANK



SHOT ROCK REQ'D. FOR CHANNEL:

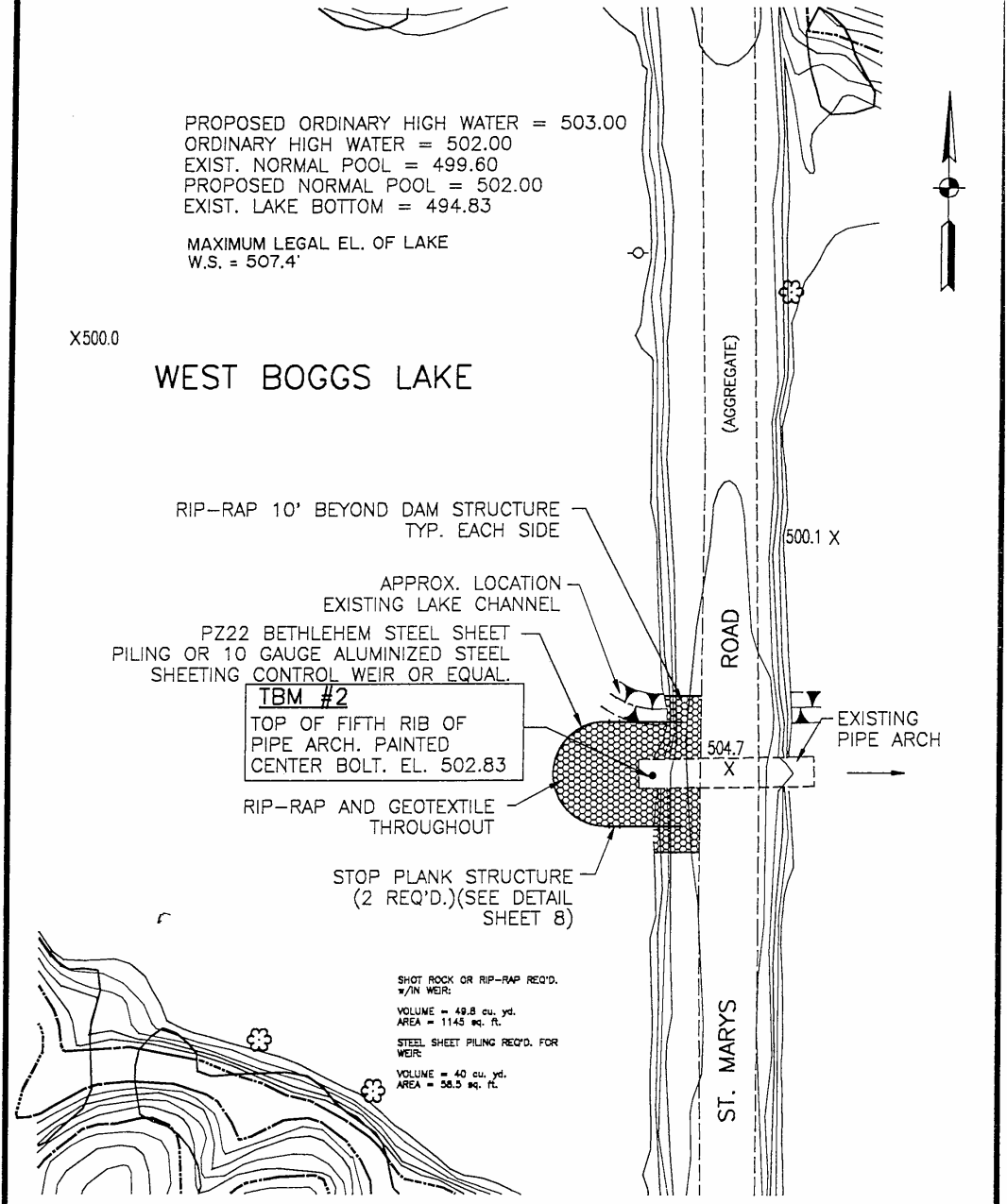
VOLUME = 27 cu. yd.
AREA = 611 sq. ft.

TYPICAL CROSS SECTION

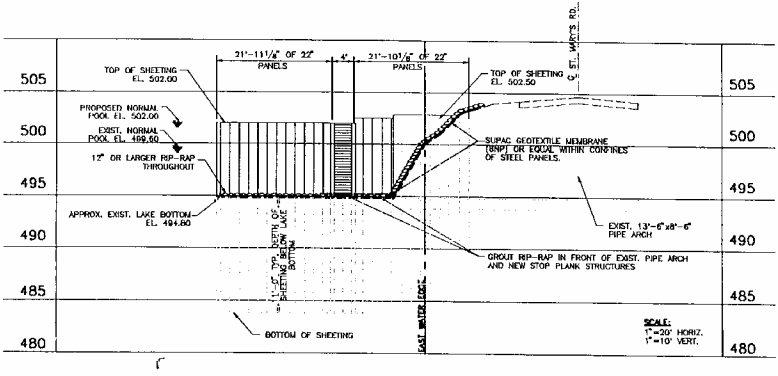
SCALE: 1"=5' HORIZ.
1"=5' VERT.

COMMONWEALTH ENGINEERS, INC.

TITLE: CHANNEL FLOW DAVIESS STR.-SECTION
LOCATION: AREA 1
APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD
NEAR: LOOGOOTEE, INDIANA
COUNTY: DAVIESS COUNTY
DATE: 12/93
DWG. NO.: 7 OF 13



COMMONWEALTH ENGINEERS, INC.	TITLE: SHEET PILING DAM SITE PLAN	APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD	
	LOCATION: AREA 1	NEAR: LOOGOOTEE, INDIANA	
	COUNTY: DAVIESS COUNTY	DATE: 11/29/93	SCALE: 1"=50'-0"
			DWG. NO.: 8 OF 13



NOTE:
IT MAY BE NECESSARY TO INSTALL A GEOGRID SUCH AS "TENSAR BX2100" OR EQUAL FOR ACCESS DEPENDING ON SOIL MOISTURE.

SHOT ROCK OR RIP-RAP REQ'D. w/IN WEIR:

VOLUME = 49.8 cu. yd.
AREA = 1145 sq. ft.

STEEL SHEET PILING REQ'D.:

VOLUME = 40 cu. yd.
AREA = 58.5 sq. ft.

ROAD ARMOR REQ'D.:

VOLUME = 7.4 cu. yd.
AREA = 300 sq. ft.

LAKE PROFILE WITHIN PROPOSED STEEL SHEETING WEIR

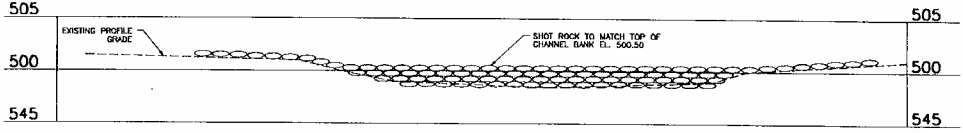
PROPOSED ORDINARY HIGH WATER = 503.00
EXIST. ORDINARY HIGH WATER = 502.00
EXIST. NORMAL POOL = 499.60
PROPOSED NORMAL POOL = 502
EXIST. ORDINARY LOW WATER = 498.00

COMMONWEALTH ENGINEERS, INC.

TITLE: SHEET PILING WEIR SITE - SECTION
LOCATION: AREA 1 NEAR: LOOGOOTEE, INDIANA
APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD
COUNTY: DAVIESS COUNTY
DATE: 12/93
SCALE: AS NOTED
DWG. NO.: 9 OF 13

COMMONWEALTH ENGINEERS, INC.

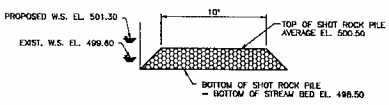
TITLE: FLOW DIVERSION STRUCTURE - PLAN
APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD
LOCATION: AREA 2
NEAR: LOGGOOTEE, INDIANA
COUNTY: DAVIESS COUNTY
DATE: 12/93
SCALE: 1"=100'-0"
DWG. NO.: 10 OF 13



PROFILE

SCALE: 1"=5' HORIZ.
1"=10' VERT.

ORDINARY HIGH WATER = 502.00
EXIST. NORMAL POOL = 499.60
PROPOSED NORMAL POOL = 501.30
ORDINARY LOW WATER = 498.00



TYPICAL CROSS SECTION

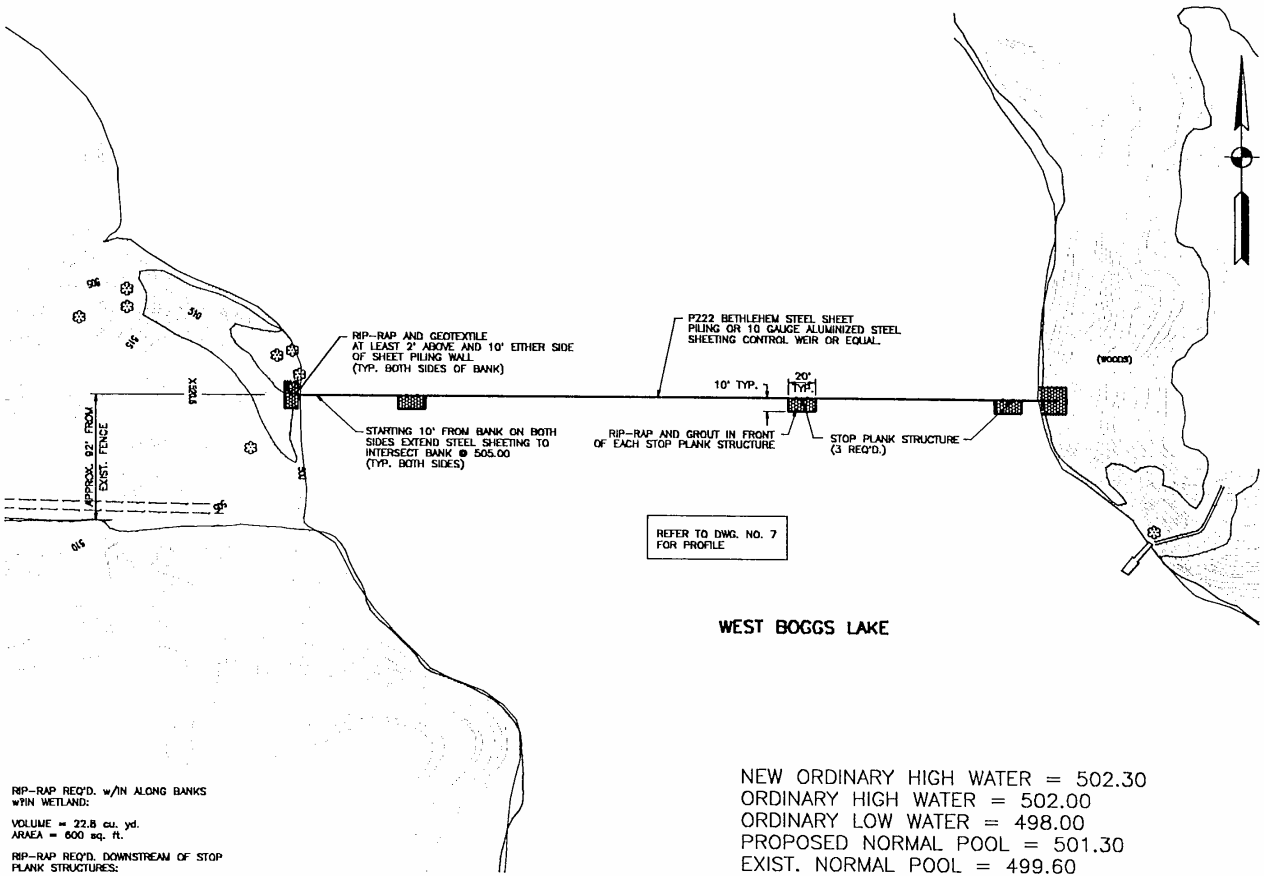
SCALE: 1"=5' HORIZ.
1"=10' VERT.

SHOT ROCK REQ'D. IN CHANNEL:

VOLUME = 36.2 cu. yd.
AREA = 780 sq. ft.

COMMONWEALTH ENGINEERS, INC.

TITLE: CHANNEL FLOW DIVERSION STRUCTURE - SECTION
LOCATION: AREA 2
COUNTY: DAVIESS COUNTY
DATE: 12/93
APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD
NEAR: LOOGOOTEE, INDIANA
SCALE: AS NOTED
DWG. NO.: 11 OF 13



RIP-RAP REQ'D. w/IN ALONG BANKS w/IN WETLAND:

VOLUME = 22.8 cu. yd.
AREA = 600 sq. ft.

RIP-RAP REQ'D. DOWNSTREAM OF STOP PLANK STRUCTURES:

VOLUME = 33.4 cu. yd.
AREA = 600 sq. ft.

STEEL SHEETING REQ'D. FOR WEIR:

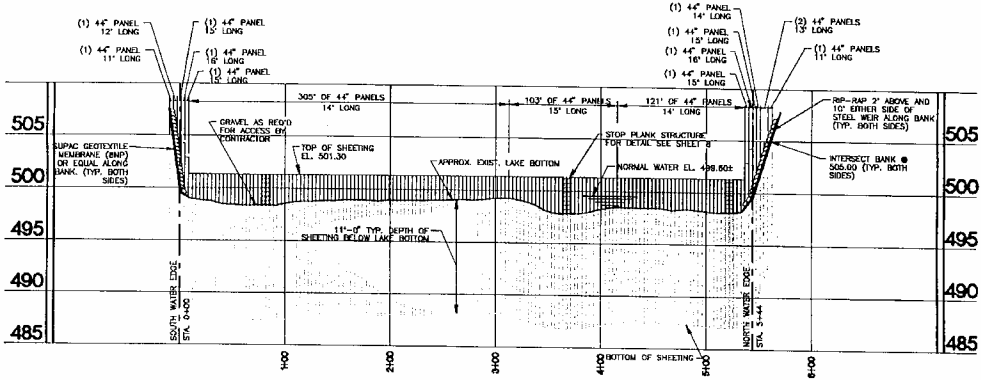
VOLUME 170 cu. yd.
AREA = 307 sq. ft.

NEW ORDINARY HIGH WATER = 502.30
ORDINARY HIGH WATER = 502.00
ORDINARY LOW WATER = 498.00
PROPOSED NORMAL POOL = 501.30
EXIST. NORMAL POOL = 499.60

MAXIMUM LEGAL EL. OF LAKE
W.S. = 507.4'

COMMONWEALTH ENGINEERS INC.

TITLE:	SHEET PILING DAM SITE PLAN
LOCATION:	AREA 2
APPLICANT:	DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD
NEAR:	LOOGOOTEE, INDIANA
COUNTY:	DAVIESS COUNTY
DATE:	12/93
SCALE:	1"=100'
DWG. NO.:	12 OF 13



NOTE:
IT MAY BE NECESSARY TO INSTALL A GEOGRID SUCH AS "TENSAR BX1200" AND/OR CRUSHED STONE FOR ACCESS DEPENDING ON SOIL MOISTURE.

ONE (1) 44" PANEL EQUALS TWO (2) PREASSEMBLED (PZ22) BETHLEHEM STEEL SHEETS OR EQUAL.

RIP-RAP REQ'D. ALONG BANK w/IN WETLAND:

VOLUME = 27.8 cu. yd.
AREA = 600 sq. ft.

RIP-RAP REQ'D. DOWNSTREAM OF STOP PLANK STRUCTURES:

VOLUME = 33.4 cu. yd.
AREA = 600 sq. ft.

STEEL SHEET PILING REQ'D.:

VOLUME = 170 cu. yd.
AREA = 307 sq. ft.

LAKE PROFILE ALONG PROPOSED STEEL SHEETING DAM LOCATION "BETHLEHEM STEEL"

SCALE: VERT. 1"=10'
HORIZ. 1"=100'

PROPOSED ORDINARY HIGH WATER = 502.30
ORDINARY HIGH WATER = 502.00
ORDINARY LOW WATER = 498.00
EXIST. NORMAL POOL = 499.60
PROPOSED NORMAL POOL = 501.30

SITSEC3.DWG

COMMONWEALTH ENGINEERS, INC.

TITLE: SHEET PILING WEIR - SECTION
LOCATION: AREA 2
NEAR: LOGOOTEE, INDIANA
COUNTY: DAVIESS COUNTY
DATE: 12/93
SCALE: AS NOTED
DWG. NO.: 13 of 13
APPLICANT: DAVIESS-MARTIN COUNTY JOINT PARK & REC. BOARD

Appendix A

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xxxxxxxxxxxxxxxxxxx80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGYxxxxxxxxxxxxxxxxxx

JOB TR-20
TITLE   1 West Boggs Lake - 100 year 24 hour storm hydrograph for the          1
TITLE     entire lake drainage area.
 7 RAINFL 7                      .2
 8                 0.0       0.021       0.042       0.063       0.100
 8               0.136       0.173       0.227       0.280       0.353
 8               0.399       0.465       0.531       0.586       0.641
 8               0.696       0.726       0.756       0.756       0.809
 8               0.833       0.856       0.875       0.897       0.917
 8               0.933       0.949       0.965       0.977       0.988
 8                 1.0         1.0         1.0         1.0         1.0
 9 ENDTBL
 5 STRUCT      1
 8                           499.6         0.0         0.0
 8                           500.1        10.0       250.0
 8                           500.5        40.0       650.0
 8                           501.1       110.0      1100.0
 8                           501.6       200.0      1450.0
 8                           502.1       290.0      1850.0
 8                           502.6       310.0      2250.0
 8                           503.1       780.0      2600.0
 8                           503.6       400.0      3000.0
 8                           504.1       800.0      3400.0
 8                           504.6      1100.0      3800.0
 8                           505.1      1800.0      4350.0
 9 ENDTBL
 5 RUNOFF 1     1    1       17.27        75.0       2.771 1   1 1 1
 6 RESVOR 2     1 1  1       499.6                       1 1 1 1 1 1
   ENDATA
 7 INCREM 6                    0.25
 7 COMPUT 7     1    1         0.0        8.01        1.02 2   1   1
   ENDCMP 1
 7 INCREM 6                    0.20
 7 COMPUT 7     1    1         0.0       -4.88        1.07 2   1   1
   ENDCMP 1
   ENDJOB 2

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxEND OF 80-81 LISTxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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FILE NO. 1

COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

THE USERS MANUAL FOR THIS PROGRAM IS THE MAY 1982 DRAFT OF TR-20. CHANGES FROM THE 02/14/74 VERSION INCLUDE:

REACH ROUTING - THE MODIFIED ATT-KIN ROUTING PROCEDURE REPLACES THE CONVEX METHOD. INPUT DATA PREPARED FOR PREVIOUS PROGRAM VERSIONS USING CONVEX ROUTING COEFFICIENTS WILL NOT RUN ON THIS VERSION.

THE PREFERRED TYPE OF DATA ENTRY IS CROSS SECTION DATA REPRESENTATIVE OF A REACH. IT IS RECOMMENDED THAT THE OPTIONAL CROSS SECTION DISCHARGE-AREA PLOTS BE OBTAINED WHENEVER NEW CROSS SECTION DATA IS ENTERED. THE PLOTS SHOULD BE CHECKED FOR REASONABLENESS AND ADEQUACY OF INPUT DATA FOR THE COMPUTATION OF 'K' VALUES USED IN THE ROUTING PROCEDURE.

GUIDELINES FOR DETERMINING OR ANALYZING REACH LENGTHS AND COEFFICIENTS (X,K) ARE AVAILABLE IN THE USER'S MANUAL. SUMMARY TABLE 0 DISPLAYS REACH ROUTING RESULTS AND ROUTING PARAMETERS FOR COMPARISON AND CHECKING.

HYDROGRAPH GENERATION - THE PROCEDURE TO CALCULATE THE INTERVAL TIME INCREMENT AND PEAK TIME OF THE UNIT HYDROGRAPH HAVE BEEN IMPROVED. PEAK DISCHARGES AND TIMES MAY DIFFER FROM THE PREVIOUS VERSION. OUTPUT HYDROGRAPHS ARE STILL INTERPOLATED, PRINTED, AND ROUTED AT THE USER SELECTED MAIN TIME INCREMENT.

INTERMEDIATE PEAKS - METHOD ADDED TO PROVIDE DISCHARGES AT INTERMEDIATE POINTS WITHIN REACHES WITHOUT ROUTING.

OTHER - THIS VERSION CONTAINS SOME ADDITIONS TO THE INPUT AND NUMEROUS MODIFICATIONS TO THE OUTPUT. SEE OPTIONS HAVE BEEN MODIFIED AND AUGMENTED ON THE ICE RECORD. PAINTABLES ADDED. ERROR AND WARNING MESSAGES EXPANDED. AND THE SUMMARY TABLES COMPLETELY REVISED. THE HOLDOUT OPTION IS NOT OPERATIONAL AT THIS TIME.

PROGRAM QUESTIONS OR PROBLEMS SHOULD BE DIRECTED TO HYDRAULIC ENGINEERS AT THE SCS NATIONAL TECHNICAL CENTERS:

EASTERN, FT. WORTHEAST -- 816-426-2213, FORT WORTH, TX (SOUTH) -- 214-624-2213 (FTS)
LINCOLN, NE (MIDWEST) -- 541-6213 (FTS), PORTLAND, OR (WEST) -- 420-4368 (FTS)
OR HYDROLOGY UNIT, ENGINEERING DIVISION, BELTSVILLE, MD -- 436-7081 (FTS).

PROGRAM CHANGES SINCE NOV 1982:

10/17/83 - CORRECT PEAK RATE FACTOR FOR USER ENTERED DT=K
CORRECT REACH ROUTING PEAK TRAVEL TIME PRINTED WITH PULSEPLOT OPTION
5/02/85 - CORRECT COMPUTATIONS FOR ---
1. DIVERSION OF BASEFLOW IN DIVERT OPERATION
2. HYDROGRAPH VOLUME SPLIT BETWEEN BASEFLOW AND ABOVE BASEFLOW
3. CROSS SECTION DATA PLOTTING POSITION
4. INTERMEDIATE PEAK WHEN TRIBUTARY AREA IS LARGER THAN TOTAL AREA
5. STORAGE ROUTED REACH TRAVEL TIME FOR MULTIPEAK HYDROGRAPH
6. RECEIVING FLOW-PROJ FILE FROM SUMMARY TABLE #2 DATA
7. BASEFLOW ENTERED WITH REACHES
8. LOW FLOW SPLIT DURING DIVERT PROCEDURE WHEN SECTION RATINGS START AT DIFFERENT ELEVATIONS
ENHANCEMENTS ---
1. REPLACE USER FATAL ERROR CODES (PAGE A-9 TO A-11) WITH MESSAGES
2. LABEL OUTPUT HYDROGRAPH FILES WITH CROSS SECTION/STRUCTURE, ALTERNATE AND STORM NO.'S
09/01/93 - CORRECT INPUT AND OUTPUT ERRORS FOR INTERMEDIATE PEAKS
CORRECT COMBINATION OF RATING TABLES FOR DIVERT

TR20 XEQ 10/25/93 West Boggs Lake storm hydrograph for the 1 JOB 1 PAGE 1
REV 09/01/83 entire lake drainage area. PAGE 2

EXECUTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = .25 HOURS RECORD ID

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO STRUCTURE 1 RECORD ID
STARTING TIME = .00 RAIN DEPTH = 6.01 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = .25 HOURS

OPERATION RUNOFF STRUCTURE 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.72	8295.36	(RUNOFF)

TIME(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .25 HOURS DRAINAGE AREA = 13.27 SQ.MI.

5.00	DISCHG	.00	.00	.00	.00	.00	.01	.14	.60	1.81	4.15
7.50	DISCHG	8.25	14.40	22.85	33.79	47.45	64.10	84.10	107.59	135.59	167.58
10.00	DISCHG	203.99	245.25	292.75	349.87	417.53	505.05	634.06	901.13	1405.35	2306.60
12.50	DISCHG	3521.48	4969.75	6408.98	7539.26	8147.69	8295.40	8051.88	7512.50	6741.47	5866.17
15.00	DISCHG	5023.45	4407.21	3894.99	3434.22	3035.70	2696.75	2412.70	2173.85	1972.09	1801.99
17.50	DISCHG	1659.34	1538.81	1434.64	1344.32	1264.42	1192.22	1126.41	1067.31	1016.23	972.04
20.00	DISCHG	931.75	894.00	857.61	821.76	787.73	756.90	729.71	702.73	677.59	659.67
22.50	DISCHG	640.18	630.21	620.20	612.31	606.08	601.07	595.99	587.17	571.37	545.04
25.00	DISCHG	505.83	455.48	398.51	339.57	282.46	230.06	184.32	146.56	116.85	93.58
27.50	DISCHG	74.96	59.97	47.53	38.13	30.38	24.18	19.26	15.32	12.18	9.65
30.00	DISCHG	7.61	5.97	4.64	3.57	2.72	2.03	1.49	1.06	.67	.39
32.50	DISCHG	.18	.05	.00							

RUNOFF VOLUME ABOVE BASEFLOW = 3.96 WATERSHED INCHES, 33898.79 CFS-HRS, 2801.40 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

OPERATION RESVOR STRUCTURE 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
25.63	356.07	502.93

TIME(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .25 HOURS DRAINAGE AREA = 13.27 SQ.MI.

7.50	DISCHG	.01	.02	.03	.06	.09	.14	.20	.28	.38	.51
7.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.61	499.61	499.61	499.62	499.62
10.00	DISCHG	.66	.84	1.06	1.33	1.64	2.02	2.49	3.12	4.03	5.60
10.00	ELEV	499.63	499.64	499.65	499.67	499.68	499.70	499.72	499.76	499.81	499.88
12.50	DISCHG	8.10	12.88	21.71	32.60	49.52	75.74	103.77	137.04	174.07	203.87
12.50	ELEV	500.00	500.15	500.30	500.48	500.67	500.86	501.04	501.23	501.46	501.60
15.00	DISCHG	220.14	234.19	246.35	256.90	265.85	273.80	280.24	286.17	291.44	296.14
15.00	ELEV	501.77	501.88	501.99	502.07	502.16	502.24	502.30	502.36	502.41	502.46
17.50	DISCHG	300.37	304.20	307.68	311.07	314.65	317.95	320.99	323.79	326.36	328.79

EXECUTIVE CONTROL OPERATION ENDCMP   COMPUTATIONS COMPLETED FOR PASS 1   RECORD ID

EXECUTIVE CONTROL OPERATION INCREM   MAIN TIME INCREMENT = .20 HOURS   RECORD ID

EXECUTIVE CONTROL OPERATION COMPUT   FROM STRUCTURE 1 TO STRUCTURE 1   RECORD ID
STARTING TIME = .00   RAIN DEPTH = 4.65   RAIN DURATION= 1.00   RAIN TABLE NO.= 7   ANT. MOIST. COND= 2
ALTERNATE NO.= 2   STORM NO.= 1   MAIN TIME INCREMENT = .20 HOURS

OPERATION RUNOFF   STRUCTURE 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
4.59	5116.17	(RUNOFF)

TIME(HRS)   FIRST HYDROGRAPH POINT = .00 HOURS   TIME INCREMENT = .20 HOURS   DRAINAGE AREA = 10.27 SQ.MI.

.00	DISCHG	.00	.00	.00	.00	.00	.67	5.27	21.94	61.92	139.40
2.00	DISCHG	273.75	484.46	785.29	1176.57	1632.45	2195.25	2772.90	3346.29	3879.26	4239.54
4.00	DISCHG	4699.46	4945.37	5080.06	5116.02	5069.97	4960.59	4808.48	4631.07	4438.26	4239.15
6.00	DISCHG	4040.04	3837.10	3623.79	3397.47	3154.68	2892.94	2615.56	2330.20	2047.22	1776.65
8.00	DISCHG	1523.40	1293.96	1090.54	915.03	762.17	637.59	534.62	448.60	376.69	316.09
10.00	DISCHG	264.77	221.46	184.95	154.05	127.81	105.59	86.87	71.15	58.15	47.38
12.00	DISCHG	38.51	31.27	25.31	20.35	16.25	12.85	10.06	7.74	5.85	4.28
14.00	DISCHG	3.00	1.96	1.16	.62	.25	.04	.00			

RUNOFF VOLUME ABOVE BASEFLOW = 3.27 WATERSHED INCHES, 21647.64 CFS-HRS, 1789.46 ACRE-FEET;   BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 2, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

OPERATION RESVOR   STRUCTURE 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
10.14	235.32	501.89

TIME(HRS)   FIRST HYDROGRAPH POINT = .00 HOURS   TIME INCREMENT = .20 HOURS   DRAINAGE AREA = 10.27 SQ.MI.

.00	DISCHG	.00	.00	.00	.00	.00	.00	.00	.00	.04	.11
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.61
2.00	DISCHG	.12	.49	.91	1.56	2.49	3.76	5.40	7.42	9.80	12.71
2.00	ELEV	499.61	499.62	499.65	499.68	499.72	499.79	499.87	499.97	500.09	500.18
4.00	DISCHG	21.09	26.04	32.42	38.70	50.23	60.00	73.41	87.33	98.73	109.64
4.00	ELEV	500.27	500.37	500.47	500.58	500.67	500.76	500.85	500.94	501.02	501.10
6.00	DISCHG	126.51	142.67	157.88	172.10	185.07	197.01	204.76	210.73	215.07	219.43
6.00	ELEV	501.19	501.29	501.37	501.45	501.52	501.59	501.64	501.69	501.73	501.76

8.00	DISCHG	223.02	228.95	229.55	230.26	231.77	232.93	233.80	234.44	234.88	235.16
8.00	ELEV	501.79	501.82	501.84	501.85	501.86	501.87	501.88	501.89	501.89	501.89
10.00	DISCHG	235.29	235.31	235.20	235.07	234.84	234.54	234.20	233.82	233.40	232.95
10.00	ELEV	501.89	501.89	501.89	501.89	501.89	501.89	501.89	501.88	501.88	501.87
12.00	DISCHG	232.48	231.99	231.49	230.97	230.44	229.91	229.37	228.82	228.27	227.72
12.00	ELEV	501.87	501.87	501.86	501.86	501.85	501.85	501.84	501.84	501.84	501.83
14.00	DISCHG	227.16	226.61	226.05	225.49	224.94	224.38	223.82	223.27	222.72	222.17
14.00	ELEV	501.83	501.82	501.82	501.81	501.81	501.80	501.80	501.79	501.79	501.78
16.00	DISCHG	221.62	221.07	220.52	219.97	219.43	218.89	218.34	217.80	217.26	216.72
16.00	ELEV	501.78	501.78	501.77	501.77	501.76	501.76	501.75	501.75	501.74	501.74
18.00	DISCHG	216.19	215.65	215.12	214.59	214.06	213.53	213.00	212.47	211.94	211.42
18.00	ELEV	501.73	501.73	501.73	501.72	501.72	501.71	501.71	501.70	501.70	501.70
20.00	DISCHG	210.89	210.37	209.85	209.33	208.81	208.30	207.78	207.27	206.75	206.24
20.00	ELEV	501.69	501.69	501.68	501.68	501.67	501.67	501.66	501.66	501.66	501.65
22.00	DISCHG	205.73	205.22	204.71	204.21	203.70	203.20	202.69	202.19	201.69	201.19
22.00	ELEV	501.65	501.64	501.64	501.64	501.63	501.63	501.62	501.62	501.61	501.61
24.00	DISCHG	200.69	200.19	199.48	198.64	197.80	196.96	196.10	195.29	194.46	193.64
24.00	ELEV	501.61	501.60	501.60	501.59	501.59	501.58	501.58	501.57	501.57	501.56
26.00	DISCHG	192.80	192.00	191.18	190.37	189.57	188.76	187.96	187.16	186.37	185.58
26.00	ELEV	501.56	501.55	501.55	501.55	501.54	501.54	501.53	501.53	501.53	501.52
28.00	DISCHG	184.79	184.01	183.23	182.45	181.68	180.91	180.14	179.38	178.61	177.86
28.00	ELEV	501.52	501.51	501.51	501.50	501.50	501.49	501.49	501.49	501.48	501.48
30.00	DISCHG	177.10	176.35	175.60	174.86	174.12	173.38	172.64	171.91	171.18	170.46
30.00	ELEV	501.47	501.47	501.46	501.46	501.46	501.45	501.45	501.44	501.44	501.43
32.00	DISCHG	169.73	169.01	168.30	167.58	166.87	166.16	165.46	164.75	164.05	163.36
32.00	ELEV	501.43	501.42	501.42	501.42	501.41	501.41	501.41	501.40	501.40	501.40
34.00	DISCHG	162.67	161.98	161.29	160.61	159.93	159.25	158.57	157.90	157.23	156.56
34.00	ELEV	501.39	501.39	501.38	501.38	501.38	501.37	501.37	501.37	501.36	501.36
36.00	DISCHG	155.90	155.24	154.58	153.93	153.27	152.62	151.98	151.33	150.69	150.05
36.00	ELEV	501.35	501.35	501.35	501.34	501.34	501.34	501.33	501.33	501.33	501.32
38.00	DISCHG	149.41	148.78	148.15	147.52	146.89	146.27	145.65	145.03	144.42	143.81
38.00	ELEV	501.32	501.32	501.31	501.31	501.31	501.30	501.30	501.29	501.29	501.29
40.00	DISCHG	143.21	142.59	141.99	141.39	140.79	140.19	139.59	139.00	138.41	137.82
40.00	ELEV	501.28	501.28	501.28	501.27	501.27	501.27	501.26	501.26	501.26	501.25
42.00	DISCHG	137.24	136.66	136.08	135.51	134.93	134.36	133.79	133.23	132.66	132.10
42.00	ELEV	501.25	501.25	501.24	501.24	501.24	501.24	501.23	501.23	501.23	501.22
44.00	DISCHG	131.55	130.99	130.44	129.89	129.35	128.80	128.26	127.73	127.19	126.66
44.00	ELEV	501.22	501.22	501.21	501.21	501.21	501.20	501.20	501.20	501.20	501.19
46.00	DISCHG	126.05	125.52	124.99	124.46	123.93	123.41	122.88	122.36	121.84	121.32
46.00	ELEV	501.19	501.19	501.18	501.18	501.18	501.17	501.17	501.17	501.17	501.16
48.00	DISCHG	120.81	120.30	119.79	119.29	118.78	118.28	117.77	117.27	116.77	116.27
48.00	ELEV	501.16	501.16	501.15	501.15	501.15	501.15	501.14	501.14	501.14	501.13
50.00	DISCHG	115.78	115.29	114.81	114.31	113.83	113.35	112.87	112.39	111.91	111.44
50.00	ELEV	501.13	501.13	501.13	501.12	501.12	501.12	501.12	501.11	501.11	501.11
52.00	DISCHG	110.56	110.28	110.00	109.72	109.45	109.17	108.89	108.61	108.33	108.05
52.00	ELEV	501.11	501.10	501.10	501.10	501.10	501.09	501.09	501.09	501.09	501.09
54.00	DISCHG	107.77	107.50	107.22	106.95	106.67	106.40	106.12	105.85	105.58	105.31
54.00	ELEV	501.08	501.08	501.08	501.08	501.08	501.07	501.07	501.07	501.07	501.07
56.00	DISCHG	105.04	104.77	104.50	104.23	103.96	103.70	103.43	103.17	102.90	102.64

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 TR20 XEQ 10/25/97              West Bagga Lake -                 storm hydrograph for the          -             JOB  1   PAGE   1
      REV 09/01/92              entire lake drainage area.                                                        PAGE   2


   56.00      ELEV      501.06    501.06    501.06    501.06    501.06    501.05    501.05    501.05    501.05    501.05
   53.00    DISCHG      102.37    102.11    101.85    101.57    101.28    101.01    100.81    100.65    100.27    100.07
   58.00      ELEV      501.05    501.04    501.04    501.04    501.04    501.03    501.07    501.03    501.07


  RUNOFF VOLUME ABOVE BASEFLOW =  1.06 WATERSHED INCHES,   9112.98 CFS-HRS,   783.10 ACRE-FEET;   BASEFLOW =    .00 CFS

                        --- HYDROGRAPH FOR STRUCTURE  1, ALTERNATE  2, STORM  1, FILED TO OUTPUT HYDROGRAPH FILE ---


EXECUTIVE CONTROL OPERATION ENDCMP     COMPUTATIONS COMPLETED FOR PASS   2                                          RECORD 10




EXECUTIVE CONTROL OPERATION ENDJOB                                                                                RECORD 11
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SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 1														
STRUCTURE	1	RUNOFF	13.27	2	2	.25	.0	6.31	24.00	3.96	---	11.72	8266.36	615.0
STRUCTURE	1	RESVOR	13.27	2	2	.25	.0	6.31	24.00	1.96	501.93	25.66	356.07	26.8
ALTERNATE 2 STORM 1														
STRUCTURE	1	RUNOFF	13.27	7	2	.20	.0	4.65	6.00	2.50	---	4.59	5116.17	385.5
STRUCTURE	1	RESVOR	13.27	7	2	.20	.0	4.69	6.00	1.06	501.59	10.14	235.32	17.7

SUMMARY TABLE 1 - DISCHARGE (CFS) AT SECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

SECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBER..... 1
STRUCTURE 1	13.17	
ALTERNATE 1		731.97
ALTERNATE 2		235.72

Appendix B

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**************************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*************************

JOB TR-20
TITLE    1 West Boggs Lake - 100 year 24 hour storm hydrograph for the          1
TITLE      Area/ ~~entire~~ lake drainage area.
 6 RUNOFF 1     1     1          1.93         79.0        2.011 1   1 1 1
 6 RESVOR 2     1 1   2         495.6                          1 1 1 1 1 1
   ENDATA
 7 INCREM 6                      0.25
 7 COMPUT 7     1     1           0.0         6.31         1.02 2   1   1
   ENDCMP 1
   ENDJOB 2

*********************************END OF 80-80 LIST*************************************
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$T_c = 2.01$

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO STRUCTURE 1 RECORD II

STARTING TIME = .00 RAIN DEPTH = 6.31 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 1

ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = .25 HOURS

OPERATION RUNOFF STRUCTURE 1

TIME(HRS)		FIRST HYDROGRAPH POINT = .00 HOURS				TIME INCREMENT = .25 HOURS			DRAINAGE AREA =		1.94 SQ.MI.
5.00	DISCHG	.00	.00	.00	.00	.00	.01	.05	.21	.60	1.37
7.50	DISCHG	2.80	4.32	6.45	8.96	11.92	15.46	19.65	24.58	30.14	36.42
10.00	DISCHG	43.41	51.02	60.19	71.05	85.15	104.22	132.15	195.82	359.42	637.12
12.50	DISCHG	1004.98	1328.75	1506.40	1525.22	1425.31	1242.69	1030.31	851.25	713.14	602.72
15.00	DISCHG	510.17	437.38	376.12	330.65	292.96	262.96	239.18	220.32	205.09	192.46
17.50	DISCHG	181.47	171.25	162.79	154.51	146.68	140.24	134.31	127.10	124.76	120.79
20.00	DISCHG	116.45	113.45	111.91	107.70	103.27	99.07	95.42	92.57	90.21	88.51
22.50	DISCHG	87.87	87.03	86.52	86.12	85.80	85.57	84.70	83.08	77.48	69.47
25.00	DISCHG	63.78	47.80	36.56	27.18	19.79	14.56	10.77	7.94	5.84	4.28
27.50	DISCHG	3.14	2.29	1.65	1.20	.86	.60	.42	.28	.18	.10
30.00	DISCHG	.04	.01	.00							

RUNOFF VOLUME ABOVE BASEFLOW = 3.45 WATERSHED INCHES, 4847.42 CFS-HRS, 403.51 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO STRUCTURE 1 RECORD ID

STARTING TIME = .00 RAIN DEPTH = 3.20 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2

ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = .25 HOURS

OPERATION RUNOFF STRUCTURE 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
15.24	496.23	(RUNOFF)

TIME(HRS)		FIRST HYDROGRAPH POINT = .00 HOURS				TIME INCREMENT = .25 HOURS			DRAINAGE AREA = 1.93 SQ.MI.		
7.50	DISCHG	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02
10.00	DISCHG	.03	.03	.91	2.07	4.12	7.53	13.33	29.62	75.24	157.21
12.50	DISCHG	259.40	466.14	477.03	496.20	474.06	422.15	356.39	299.50	254.71	218.03
15.00	DISCHG	187.38	162.71	142.38	125.90	112.70	102.12	93.70	87.00	81.54	76.75
17.50	DISCHG	72.84	68.45	64.15	60.01	60.02	57.46	55.14	53.09	51.26	50.62
20.00	DISCHG	48.69	47.72	46.30	44.60	42.81	41.11	39.53	38.45	37.50	37.04
22.50	DISCHG	36.62	36.33	36.12	35.98	35.89	35.79	35.47	34.52	32.48	29.14
25.00	DISCHG	24.74	19.64	15.36	11.40	8.31	6.11	4.52	3.33	2.45	1.81
27.50	DISCHG	1.32	.96	.70	.50	.36	.25	.18	.12	.07	.04
30.00	DISCHG	.02	.01	.00							

RUNOFF VOLUME ABOVE BASEFLOW = 1.15 WATERSHED INCHES, 1681.18 CFS-HRS, 137.25 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

EXECUTIVE CONTROL OPERATION COMPUT   FROM STRUCTURE 1 TO STRUCTURE 1   RECORD ID

STARTING TIME =   .00   RAIN DEPTH = 4.52   RAIN DURATION= 1.00   RAIN TABLE NO.= 2   ANT. MOIST. COND= 2

ALTERNATE NO.= 1   STORM NO.= 1   MAIN TIME INCREMENT =   .25 HOURS

OPERATION RUNOFF   STRUCTURE 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.20	914.30	(RUNOFF)

TIME(HRS)   FIRST HYDROGRAPH POINT =   .00 HOURS   TIME INCREMENT = .25 HOURS   DRAINAGE AREA =   1.90 SQ.MI.

7.50	DISCHG	.00	.00	.01	.05	.23	.66	1.48	2.79	4.65	7.09
10.00	DISCHG	10.12	13.77	18.17	23.66	30.85	40.70	55.35	90.84	165.25	351.41
12.50	DISCHG	573.63	775.31	891.42	912.64	850.10	756.29	631.74	525.45	442.36	376.54
15.00	DISCHG	320.44	278.21	240.89	210.23	187.61	169.07	154.34	142.15	133.47	125.24
17.50	DISCHG	118.79	112.35	106.74	101.41	96.41	92.03	88.39	85.02	82.21	81.00
20.00	DISCHG	79.13	76.20	73.82	71.13	65.23	65.48	63.10	61.21	59.24	52.32
22.50	DISCHG	58.19	57.69	57.33	57.02	56.91	56.77	56.19	54.67	51.47	46.12
25.00	DISCHG	39.12	31.56	24.30	18.03	13.14	9.47	7.15	5.07	3.55	2.35
27.50	DISCHG	2.08	1.52	1.10	.80	.57	.40	.28	.18	.12	.07
30.00	DISCHG	.03	.01	.00							

RUNOFF VOLUME ABOVE BASEFLOW = 2.39 WATERSHED INCHES,   2574.01 CFS-HRS,   245.77 ACRE-FEET;   BASEFLOW =   .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

```
*********************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*********************

JOB TR-20
TITLE   1 West Boggs Lake - 2 year 24 hour storm hydrograph for the          1
TITLE     entire lake drainage area.
 6 RUNOFF 1     1     1         3.27        79.0        2.37! 1   1 1 1
 6 RESVOR 2     1 1   2        477.6                        1 1 1 1 1 1
   ENDATA
 7 INCREM 6                     0.25
 7 COMPUT 7     1     1          0.0        3.20         1.02 2   1   1
   ENDCMP 1
   ENDJOB 2

*********************END OF 80-80 LIST*********************
```

```
EXECUTIVE CONTROL OPERATION COMPUT     FROM STRUCTURE  1  TO STRUCTURE  1                                    RECORD ID
        STARTING TIME =   .00    RAIN DEPTH =  3.20    RAIN DURATION=  1.00    RAIN TABLE NO.= 2    ANT. MOIST. COND= 2
        ALTERNATE NO.= 1         STORM NO.= 1    MAIN TIME INCREMENT =   .25 HOURS


OPERATION RUNOFF   STRUCTURE  1

          PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
             13.52                       744.36                       (RUNOFF)

TIME(HRS)        FIRST HYDROGRAPH POINT =   .00 HOURS     TIME INCREMENT =   .25 HOURS     DRAINAGE AREA =   3.27 SQ.MI.
  7.50   DISCHG        .00       .00       .00       .00       .00       .00       .00       .00       .00       .01
 10.00   DISCHG        .02       .33       .96      2.30      4.79      7.02     15.89     29.13     44.31     59.91
 12.50   DISCHG      33.78    462.89    632.00    716.82    744.20    724.46    669.03    599.83    505.12    436.45
 15.00   DISCHG     380.17    333.15    292.34    258.34    230.06    206.47    186.39    171.24    156.40    147.47
 17.50   DISCHG     138.46    130.45    123.55    117.46    111.89    106.50    101.53     96.83     92.58     87.10
 20.00   DISCHG      86.46     84.10     81.70     79.02     76.14     73.27     70.51     68.27     66.32     64.82
 22.50   DISCHG      63.71     62.89     62.26     61.80     61.45     61.18     60.76     59.73     57.56     53.71
 25.00   DISCHG      48.03     41.26     34.21     27.48     21.50     16.53     12.69      9.78      7.55      5.82
 27.50   DISCHG       4.48      3.44      2.64      2.02      1.54      1.18       .89       .67       .50       .37
 30.00   DISCHG        .27       .19       .13       .09       .04       .02       .01       .00

  RUNOFF VOLUME ABOVE BASEFLOW =  1.34 WATERSHED INCHES.   2818.55 CFS-HRS.   232.97 ACRE-FEET;   BASEFLOW =   .00 CFS

                  --- HYDROGRAPH FOR STRUCTURE  1, ALTERNATE  1, STORM  1, ADDED TO OUTPUT HYDROGRAPH FILE ---
```

```
**********************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*******************

JOB TR-20
TITLE   1 West Boggs Lake - 10 year 24 hour storm hydrograph for the          1
TITLE     Area 2 lake drainage area.
 6 RUNOFF 1     1     1          3.27        79.0        2.371 1   1 1 1
 6 RESVOR 2     1 1   2         499.6                       1 1 1 1 1 1
   ENDATA
 7 INCREM 6                      0.25
 7 COMPUT 7     1     1           0.0        4.52         1.02 2   1   1
   ENDCMP 1
   ENDJOB 2

*******************************************END OF 80-80 LIST*******************************
```

```
EXECUTIVE CONTROL OPERATION COMPUT     FROM STRUCTURE  1  TO STRUCTURE  1                                  RECORD ID
         STARTING TIME =   .00    RAIN DEPTH =  4.52    RAIN DURATION=  1.00    RAIN TABLE NO.= 2    ANT. MOIST. COND= 2
         ALTERNATE NO.= 1          STORM NO.= 1    MAIN TIME INCREMENT =   .25 HOURS


OPERATION RUNOFF   STRUCTURE  1

          PEAK TIME(HRS)               PEAK DISCHARGE(CFS)           PEAK ELEVATION(FEET)
            13.47                           1371.16                      (RUNOFF)
```

TIME(HRS)   FIRST HYDROGRAPH POINT =   .00 HOURS   TIME INCREMENT = .25 HOURS   DRAINAGE AREA = 3.27 SQ.MI.

7.50	DISCHG	.00	.00	.01	.06	.25	.71	1.61	3.13	5.40	8.57
10.00	DISCHG	12.59	17.67	23.91	31.70	41.81	55.38	76.43	125.43	234.21	419.55
12.50	DISCHG	676.68	963.35	1202.95	1339.86	1370.51	1317.79	1207.01	1046.72	890.45	760.21
15.00	DISCHG	660.00	574.26	500.41	409.32	355.79	346.76	311.25	284.42	261.51	240.[illegible]
17.50	DISCHG	226.88	212.99	201.06	190.59	181.11	172.15	163.61	155.64	148.43	142.71
20.00	DISCHG	138.35	134.45	130.83	126.13	121.47	116.84	112.32	108.72	105.56	103.11
22.50	DISCHG	101.30	99.93	98.85	98.16	97.51	97.02	96.31	94.64	91.17	85.06
25.00	DISCHG	76.04	65.32	54.15	43.49	34.02	26.17	20.09	15.48	11.95	9.21
27.50	DISCHG	7.08	5.44	4.13	3.19	2.44	1.86	1.41	1.06	.79	.58
30.00	DISCHG	.42	.30	.20	.13	.07	.03	.01	.00		

RUNOFF VOLUME ABOVE BASEFLOW = 2.39 WATERSHED INCHES,   5045.85 CFS-HRS,   416.99 ACRE-FEET;   BASEFLOW =   .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

```
xxxxxxxxxxxxxxxxxx80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGYxxxxxxxxxxxxxxxxxx

JOB TR-20
TITLE   1 West Boggs Lake - 100 year 24 hour storm hydrograph for the         1
TITLE     entire lake drainage area.
 5 RUNOFF 1     1     1         3.27        79.0        2.371 1   1 1 1
 6 RESVOR 2     1 1   2        499.6                       1 1 1 1 1 1
   ENDATA
 7 INCREM 6                    0.25
 7 COMPUT 7     1     1         0.0         6.31         1.02 2   1   1
   ENDCMP 1
   ENDJOB 2

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxEND OF 80-80 LISTxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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EXECUTIVE CONTROL OPERATION COMPUT     FROM STRUCTURE  1  TO STRUCTURE  1                                          RECORD IS
       STARTING TIME =   .00    RAIN DEPTH =  6.31    RAIN DURATION=  1.00    RAIN TABLE NO.= 2    ANT. MOIST. COND= 2
       ALTERNATE NO.= 1         STORM NO.= 1    MAIN TIME INCREMENT =   .25 HOURS


OPERATION RUNOFF   STRUCTURE  1

            PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
              15.45                       2288.34                      (RUNOFF)

TIME(HRS)        FIRST HYDROGRAPH POINT =   .00 HOURS      TIME INCREMENT =   .25 HOURS      DRAINAGE AREA =   3.27 SQ.MI.
   0.00    DISCHG        .00       .00       .00       .00       .00       .00       .03       .23       .67      1.56
   7.50    DISCHG       3.02      5.14      7.91     11.26     15.54     20.35     26.49     33.49     41.63     50.18
  10.00    DISCHG      61.02     72.69     86.07    102.02    122.12    146.59    186.79    277.47    465.52    776.11
  12.50    DISCHG    1307.87   1869.51   2048.22   2251.74   2282.96   2177.02   1972.10   1706.59   1440.39   1227.31
  15.00    DISCHG    1054.43    914.63    793.20    693.14    610.65    542.26    486.28    441.24    404.72    374.73
  17.50    DISCHG     348.52    326.30    307.25    290.18    275.71    261.84    248.20    235.71    224.52    215.34
  20.00    DISCHG     208.66    202.87    196.84    190.15    182.03    175.96    169.39    163.61    155.75    152.08
  22.50    DISCHG     152.27    150.19    148.55    147.31    146.37    145.60    144.49    141.94    138.70    127.31
  25.00    DISCHG     117.57     97.50     81.15     65.18     50.98     39.21     30.10     23.19     17.91     13.80
  27.50    DISCHG      10.61      8.18      6.25      4.79      3.66      2.77      2.12      1.59      1.19       .87
  30.00    DISCHG        .64       .45       .31       .19       .11       .05       .01       .00

  RUNOFF VOLUME ABOVE BASEFLOW =  3.95 WATERSHED INCHES,   8340.63 CFS-HRS,   664.50 ACRE-FEET;   BASEFLOW =   .00 CFS

                    --- HYDROGRAPH FOR STRUCTURE  1, ALTERNATE  1, STORM  1, ADDED TO OUTPUT HYDROGRAPH FILE ---
```

Appendix C

ERRE ...TE: 11-16-1993 FILE DATE: 10-17-1993
RI ...TIME: 13:57:05 FILE NAME: WBOGS

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

SITE DATA				CULVERT SHAPE, MATERIAL, INLET				
INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS	SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
494.80	494.70	68.00	1	ICMP	13.50	8.50	.035	CONVENTIONAL

SUMMARY OF CULVERT FLOWS (CFS) FILE: WBOGS DATE: 10-17-1993

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
500.80	0	0	0	0	0	0	0	0	1
[illegible]1	130	130	0	0	0	0	0	0	1
[illegible]2	260	260	0	0	0	0	0	0	1
501.96	390	390	0	0	0	0	0	0	1
3.40	520	520	0	0	0	0	0	0	1
4.18	650	592	0	0	0	0	0	57	5
504.42	780	614	0	0	0	0	0	162	8
504.59	910	628	0	0	0	0	0	275	7
4.71	1040	638	0	0	0	0	0	397	6
504.79	1170	645	0	0	0	0	0	513	4
504.87	1300	652	0	0	0	0	0	638	4
3.80	556	556	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: WBOGS DATE: 10-17-1993

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
500.80	0.00	0	0	0.00
500.91	0.00	130	0	0.00
501.22	0.00	260	0	0.00
501.96	0.00	390	0	0.00
503.40	0.00	520	0	0.00
504.18	-0.00	650	1	0.17
504.42	-0.00	780	5	0.61
504.59	-0.01	910	8	0.84
504.71	-0.00	1040	5	0.47
504.79	-0.01	1170	11	0.95
504.87	-0.01	1300	10	0.74

(1) TOLERANCE (FT) = 0.010 (2) TOLERANCE (%) = 1.000

1 JOBS IN THIS RUN 1

oo - Prograa terainated.

DATE: 11-16-1993 FILE DATE: 10-17-1993

TIME: 13:56:22 FILE NAME: WBOGS

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	494.80	494.70	68.00	1 ICMP	13.50	8.50	.035	CONVENTIONAL
2								
3								
4								
5								
6								

FILE: WBOGS CULVERT HEADWATER ELEVATION (FT) DATE: 10-17-1993

DISCHARGE	1	2	3	4	5	6	ROADWAY
0	500.80	0.00	0.00	0.00	0.00	0.00	503.80
[illegible]	500.91	0.00	0.00	0.00	0.00	0.00	504.36
[illegible]	501.22	0.00	0.00	0.00	0.00	0.00	504.57
390	501.96	0.00	0.00	0.00	0.00	0.00	504.71
520	503.40	0.00	0.00	0.00	0.00	0.00	504.80
650	504.84	0.00	0.00	0.00	0.00	0.00	504.87
780	506.49	0.00	0.00	0.00	0.00	0.00	504.94
910	508.48	0.00	0.00	0.00	0.00	0.00	505.00
1040	510.93	0.00	0.00	0.00	0.00	0.00	505.06
1170	513.87	0.00	0.00	0.00	0.00	0.00	505.12
1300	517.29	0.00	0.00	0.00	0.00	0.00	505.18
1300	517.29	0.00	0.00	0.00	0.00	0.00	0.00

The above Q and HW are for a point above the roadway.

Tailwater EL: 503.7'

CURRENT DATE: 10-12-1993
CURRENT TIME: 01:53:51

FILE DATE: 10-12-1993
FILE NAME: WEDGE

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

CROSSING	SITE DATA			CULVERT SHAPE, MATERIAL, INLET
	INLET	OUTLET	CULVERT	BARRELS
	ELEV.	ELEV.	LENGTH	SHAPE
	(FT)	(FT)	(FT)	MATERIAL
1	494.60	494.70	66.00	1 CMP

SPAN	RISE	MANNING	INLET
(FT)	(FT)	n	TYPE
13.50	8.54	.033	MITERED,

FILE: WEDGE CULVERT HEADWATER ELEVATION (FT) DATE: 10-12-1993

DISCHARGE	1	2	3	4	5	6	TAILWATER
1	501.45	0.00	0.00	0.00	0.00	0.00	503.45
100	503.01	0.00	0.00	0.00	0.00	0.00	503.45
200	503.22	0.00	0.00	0.00	0.00	0.00	503.45
300	503.41	0.00	0.00	0.00	0.00	0.00	503.45
320	503.44	0.00	0.00	0.00	0.00	0.00	503.45
400	503.54	0.00	0.00	0.00	0.00	0.00	503.45
700	503.89	0.00	0.00	0.00	0.00	0.00	503.45
900	503.42	0.00	0.00	0.00	0.00	0.00	503.45
1000	503.79	0.00	0.00	0.00	0.00	0.00	503.45
1100	503.87	0.00	0.00	0.00	0.00	0.00	503.45
1200	503.95	0.00	0.00	0.00	0.00	0.00	503.45
1300	503.99	0.00	0.00	0.00	0.00	0.00	503.45

CURRENT DATE: 10-16-1993 FILE DATE: 10-17-1993
CURRENT TIME: 01:37:05 FILE NAME: PEGS1

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

SITE DATA

INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)
504.50	494.70	48.00

CULVERT SHAPE, MATERIAL, INLET

BARRELS	SHAPE	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	ICAP	12.00	2.00	.012	CONVENTIONAL

SUMMARY OF CULVERT FLOWS (CFS) FILE: WS08 DATE: 10-17-1993

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY IT
502.50	0	0	0	0	0	0	0	0
503.01	130	130	0	0	0	0	0	0
503.37	260	260	0	0	0	0	0	0
503.61	390	390	0	0	0	0	0	0
504.05	520	494	0	0	0	0	0	16
504.32	650	554	0	0	0	0	0	45
504.47	780	586	0	0	0	0	0	123
504.61	910	612	0	0	0	0	0	237
504.72	1040	631	0	0	0	0	0	344
504.79	1170	644	0	0	0	0	0	414
504.87	1300	653	0	0	0	0	0	438
505.20	1430	653	0	0	0	0	0	438 OVERTOPPING

HEAD ELEV. (FT)	HEAD ELEV. (FT)	TOTAL FLOW (CFS)	FLOW (CFS)	ITER. NO.
502.50	0.00	0	0	0.00
503.01	0.51	130	0	0.00
503.37	0.87	260	0	0.00
503.61	1.11	390	0	0.00
504.05	-0.05	520	0	0.00
504.32	-0.32	650	0	0.00
504.47	-0.47	780	0	0.00
504.61	-0.61	910	0	0.00
504.72	-0.72	1040	0	0.00
504.79	-0.81	1170	10	0.01
504.87	-0.87	1300	9	0.01

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 10-18-1993 FILE DATE: 10-17-1993
CURRENT TIME: 01:37:05 FILE NAME: [illegible]

PERFORMANCE CURVE FOR CULVERT # 1 - 1 (13.5 BY 8.5) [illegible]

DIS- CHARGE FLOW (cfs)	HEAD- WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	502.93	0.00	8.13	0-NF	0.00	0.00	0.00	0.00	[illegible]	8.23
100	503.01	2.46	8.21	2-M1t	3.66	1.40	1.48	7.22	[illegible]	[illegible]
240	503.07	3.57	8.27	2-M1t	7.[illegible]	1.17	[illegible]	8.23	[illegible]	[illegible]
390	503.61	7.16	8.61	6-FFn	8.50	2.94	4.40	8.50	[illegible]	8.23
456	504.03	8.34	9.23	6-FFn	8.50	3.53	5.61	8.50	0.00	8.23
551	504.29	8.93	9.49	6-FFn	8.50	3.78	6.21	8.50	0.00	8.23
586	504.47	9.31	9.67	6-FFn	8.50	3.94	6.61	8.50	0.00	8.23
612	504.61	9.61	9.81	6-FFn	8.50	4.06	6.90	8.50	0.00	8.23
631	504.71	9.82	9.91	6-FFn	8.50	4.15	7.12	8.50	0.00	8.23
644	504.79	9.97	9.99	6-FFn	8.50	4.21	7.17	8.50	0.00	8.23
652	504.87	10.07	10.03	6-FFn	8.50	4.24	7.36	8.50	0.00	8.23

El. inlet face invert 494.80 ft El. outlet invert 494.70 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	0.00
INLET ELEVATION (FT)	494.80
OUTLET STATION (FT)	58.00
OUTLET ELEVATION (FT)	494.70
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0015
CULVERT LENGTH ALONG SLOPE (FT)	58.00

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	USER DEFINED
BARREL SPAN	13.50 FT
BARREL RISE	8.50 FT
BARREL MATERIAL	PLATE OR [illegible]
BARREL MANNING'S n	[illegible] FOR SIDES AND [illegible] FOR BOTTOM
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	THIN EDGE PROJECTING
INLET DEPRESSION	NONE

CURRENT DATE: 10-18-1993 FILE DATE: 10-17-1993
CURRENT TIME: 01:37:05 FILE NAME: [illegible]

***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDINATE NUMBER	X (FT)	Y-TOP (FT)	Y-BOTTOM (FT)
1	0.00	0.00	0.00
2	0.84	4.12	0.00
3	1.69	5.62	0.00
4	2.53	6.64	0.00
5	3.38	7.36	0.00
6	4.22	7.88	0.00
7	5.06	8.23	0.00
8	5.91	8.43	0.00
9	6.75	8.50	0.00
10	7.59	8.43	0.00
11	8.44	8.23	0.00
12	9.28	7.88	0.00
13	10.13	7.36	0.00
14	10.97	6.64	0.00
15	11.81	5.62	0.00
16	12.66	4.12	0.00
17	13.50	0.00	0.00

CURRENT DATE: 10-18-1773 FILE DATE: 10-17-1773
CURRENT TIME: 01:37:05 FILE NAME: XSEC

TAILWATER

CONSTANT WATER SURFACE ELEVATION
502.93

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE GRAVEL
EMBANKMENT TOP WIDTH (FT) 35.00

***** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X (FT)	Y (FT)
1	0.00	507.40
2	95.00	505.00
3	220.00	504.50
4	250.00	504.60
5	300.00	504.80
6	320.00	504.60
7	465.00	504.70
8	650.00	507.80
9	720.00	507.90
10	760.00	504.50
11	810.00	505.00
12	1010.00	510.00

CURRENT DATE: 10-19-1993 FILE DATE: [illegible]-1993
CURRENT TIME: 02:47:46 FILE NAME: XSC65

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

C U L V	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	474.60	494.70	68.00	1 CONC	[illegible]	[illegible]	[illegible]	CONVENTIONAL
2								
3								
4								
5								
6								

FILE: XSC65 CULVERT HEADWATER ELEVATION (FT) DATE: 10-17-1993

DISCHARGE	1	2	3	4	5	6	ROADWAY
[illegible]	[illegible]	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]
130	502.14	0.00	0.00	0.00	0.00	0.00	504.3
260	502.42	0.00	0.00	0.00	0.00	0.00	504.5
390	502.79	0.00	0.00	0.00	0.00	0.00	504.7
520	503.40	0.00	0.00	0.00	0.00	0.00	504.8
650	504.24	0.00	0.00	0.00	0.00	0.00	504.E
780	506.49	0.00	0.00	0.00	0.00	0.00	[illegible]
910	508.48	0.00	0.00	0.00	[illegible]	0.00	[illegible]
1040	511.77	0.00	0.00	0.00	0.00	0.00	[illegible]
1170	511.87	0.00	0.00	[illegible]	0.00	[illegible]	[illegible]
[illegible]	[illegible]	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.00	[illegible]	[illegible]	[illegible]	[illegible]

The above Q and HW are for a culvert above the roadway.

CURRENT DATE: [illegible] FILE DATE: [illegible]
CURRENT TIME: [illegible] FILE NAME: [illegible]

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

C U L V	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	[illegible]	[illegible]	[illegible]	1 CONC	[illegible]	[illegible]	.015	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS)

ELEV (FT)	TOTAL	1	2	3	4	5	6	CONTROL
502.10	0	0	0	0	0	0	0	0
502.19	130	130	0	0	0	0	0	1
502.42	260	260	0	0	0	0	0	1
502.75	390	390	0	0	0	0	0	1
503.40	520	520	0	0	0	0	0	1
504.18	650	650	0	0	0	0	0	1
504.42	780	614	0	0	0	0	0	1
504.59	910	628	0	0	0	0	0	1
504.71	1040	673	0	0	0	0	0	1
504.79	1170	645	0	0	0	0	0	1
504.87	1300	652	0	0	0	0	0	1
503.80	556	556	0	0	0	0	0	OVERTOPPING

SUMMARY OF ITERATIVE SOLUTION ERROR

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	%FLOW ERROR
502.10	0.00	0	0	0.0
502.19	0.00	130	0	0.0
502.42	0.00	260	0	0.00
502.75	0.00	390	0	0.00
503.40	0.00	520	0	0.00
504.18	-0.00	650	0	0.00
504.42	-0.00	780	5	0.61
504.59	-0.01	910	3	0.34
504.71	-0.00	1040	2	0.19
504.79	-0.01	1170	11	0.95
504.87	-0.01	1300	10	0.74

(1) TOLERANCE (FT) = 0.010 (2) TOLERANCE (%) = 1.00

Tailwater 501.[illegible]'

CURRENT DATE: 10-18-1993 FILE DATE: 10-17-1993
CURRENT TIME: 01:38:00 FILE NAME: WS095

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

C U L V	SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	494.80	494.70	68.00	1 ICMP	13.50	8.50	.033	CONVENTIONAL
2								
3								
4								
5								
6								

FILE: WS095 CULVERT HEADWATER ELEVATION (FT) DATE: 10-17-1993

DISCHARGE	1	2	3	4	5	6	ROADWAY
0	501.10	0.00	0.00	0.00	0.00	0.00	[illegible]
130	501.41	0.00	0.00	0.00	0.00	0.00	504.[illegible]
260	501.67	0.00	0.00	0.00	0.00	0.00	504.[illegible]
390	501.78	0.00	0.00	0.00	0.00	0.00	504.7
520	503.40	0.00	0.00	0.00	0.00	0.00	504.8
650	504.54	0.00	0.00	0.00	0.00	0.00	504.[illegible]
780	504.49	0.00	0.00	0.00	0.00	0.00	504.[illegible]
910	505.46	0.00	0.00	0.00	0.00	0.00	505.0
1040	[illegible]	0.00	0.00	0.00	0.00	0.00	505.[illegible]
1170	510.87	0.00	0.00	0.00	0.00	0.00	[illegible]
[illegible]	[illegible]	0.00	0.00	0.00	0.00	0.00	[illegible]
[illegible]	[illegible]	0.00	0.00	0.00	0.00	0.00	[illegible]

The above Q and HW are for a point above the roadway.

CURRENT DATE: 10-18-1993   FILE DATE: 10-17-199[illegible]
CURRENT TIME: [illegible]   FILE NAME: [illegible]

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

C	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
L V	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	494.80	494.70	68.00	1 ICMP	17.80	8.50	.035	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS)   FILE: [illegible]   DATE: [illegible]-17-[illegible]

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
501.00	0	0	0	0	0	0	0	0	1
501.41	[illegible]	[illegible]	0	0	0	0	0	0	1
501.67	250	250	0	0	0	0	0	0	1
501.98	390	390	0	0	0	0	0	0	1
503.40	520	520	0	0	0	0	0	0	1
504.13	[illegible]	592	0	0	0	0	0	57	[illegible]
504.42	[illegible]	614	0	0	0	0	0	152	[illegible]
504.59	[illegible]	625	0	0	0	0	0	[illegible]	[illegible]
504.71	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
504.74	[illegible]	[illegible]	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]
504.77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
504.87	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible]	TOTAL [illegible]	[illegible]	[illegible]
501.00	0.00	0	0	[illegible]
501.41	0.00	130	0	[illegible]
501.67	0.00	250	0	[illegible]
501.98	0.00	390	0	[illegible]
503.40	0.00	520	0	[illegible]
504.13	-0.00	650	[illegible]	[illegible]
504.42	[illegible]	7[illegible]	3	[illegible]
504.59	[illegible]	710	3	[illegible]
504.71	-0.0[illegible]	1040	3	[illegible]
504.77	[illegible]	[illegible]	11	[illegible]
504.87	-0.01	1300	10	0.7[illegible]

<1> TOLERANCE (FT) = 0.010   <2> TOLERANCE (%) = 1.000

Tailwater = 500.5

CURRENT DATE: 10-18-1993
CURRENT TIME: 02:44:47

FILE DATE: 10-17-1993
FILE NAME: W5065

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

C U L V #	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	494.80	494.70	65.00	1 ICMP	13.50	8.50	.035	CONVENTIONAL
2								
3								
4								
5								
6								

FILE: W5065 CULVERT HEADWATER ELEVATION (FT) DATE: 10-17-1993

DISCHARGE	1	2	3	4	5	6	ROADWAY
0	500.[illegible]	0.00	0.00	0.00	0.00	0.00	[illegible]
130	500.22	0.00	0.00	0.00	0.00	[illegible]	504.[illegible]
260	500.75	0.00	0.00	0.00	0.00	[illegible]	504.[illegible]
390	501.56	0.00	0.00	0.00	0.00	0.00	504.71
520	503.40	0.00	0.00	0.00	0.00	0.00	504.80
650	504.94	0.04	0.00	0.00	0.00	0.00	504.87
780	506.[illegible]	0.00	0.00	0.00	0.00	0.00	504.[illegible]
910	508.48	0.00	0.00	0.00	0.00	[illegible]	505.00
1040	510.[illegible]	0.00	0.00	0.00	0.00	[illegible]	505.[illegible]
1170	[illegible]	[illegible]	0.00	0.00	[illegible]	[illegible]	[illegible]
[illegible]	517.[illegible]	0.00	0.00	0.00	0.00	0.00	505.[illegible]
1300	[illegible]	0.0[illegible]	0.00	0.00	0.00	[illegible]	[illegible]

The above flows are for a point above the roadway.

CURRENT DATE: 10-18-1993   FILE DATE: 10-17-1[illegible]
CURRENT TIME: 12:46:10   FILE NAME: W8083

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

C U L V	SITE DATA INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	494.80	494.70	69.00	1 ICMP	13.50	8.30	.035	CONVENTIONA
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS)   FILE: W8083   DATE: 1[illegible]-17-19[illegible]

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
500.50	0	0	0	0	0	0	0		1
500.62	130	130	0	0	0	0	0	0	1
501.93	260	260	0	0	0	0	0	0	1
501.96	390	390	0	0	0	0	0	0	1
503.40	520	520	0	0	0	0	0	0	1
504.15	650	592	0	0	0	0	0	57	[illegible]
504.42	780	614	0	0	0	0	0	162	8
504.59	910	628	0	0	0	0	0	279	7
504.71	1040	638	0	0	0	0	0	397	6
504.79	1170	645	0	0	0	0	0	517	4
504.87	1300	652	0	0	0	0	0	678	4
[illegible]	[illegible]	[illegible]	0	0	0	0	0 OVERTOPPING		

SUMMARY OF ITERATIVE SOLUTION ERRORS   FILE: W8083   DATE: [illegible]

HEAD ELEV (FT)	HEAD ERROR (FT)	TOTAL FLOW (CFS)	FLOW ERROR (CFS)	% FLOW ERROR
500.50	0.00	0	0	0.00
500.62	0.00	130	0	0.00
500.98	0.00	260	0	0.00
501.96	0.00	390	0	0.00
503.40	0.00	520	0	0.00
504.15	-0.00	650	1	[illegible]
504.42	-0.00	780	5	[illegible]
504.59	-0.01	910	2	[illegible]
504.71	-0.01	1040	5	[illegible]
504.79	-0.01	1170	11	0.93
504.87	-0.01	1300	10	0.74

<1> TOLERANCE (FT) = 0.010   <2> TOLERANCE (%) = 1.000

Tailwater EL: 497.6

CURRENT DATE: 10-18-1993
CURRENT TIME: 01:39:10

FILE DATE: 10-17-1993
FILE NAME: WBCBS

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

SITE DATA

INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)
494.80	491.70	68.00

CULVERT SHAPE, MATERIAL, INLET

BARRELS	SHAPE	MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	CMP		13.50	6.50	.033	CONVENTIONAL

FILE: WBCBS CULVERT HEADWATER ELEVATION (FT) DATE: 10-17-1993

DISCHARGE	1	2	3	4	5	6	ROADWAY
0	495.60	0.00	0.00	0.00	0.00	0.00	503.6
130	497.77	0.00	0.00	0.00	0.00	0.00	504.7
260	500.70	0.00	0.00	0.00	0.00	0.00	504.1
390	501.96	0.00	0.00	0.00	0.00	0.00	504.7
520	503.40	0.00	0.00	0.00	0.00	0.00	504.6
650	504.84	0.00	0.00	0.00	0.00	0.00	504.6
780	506.47	0.00	0.00	0.00	0.00	0.00	504.6
910	508.48	0.00	0.00	0.00	0.00	0.00	504.6
1040	511.70	0.00	0.00	0.00	0.00	0.00	504.6
1170	516.11	0.00	0.00	0.00	0.00	0.00	504.6
1300	521.14	0.00	0.00	0.00	0.00	0.00	504.6
1330	522.24	0.00	0.00	0.00	0.00	0.00	504.6

* The above 0 air HW are ft. a point above the roadway.

CURRENT DATE: 10-18-1993 FILE DATE: 10-17-1993
CURRENT TIME: 01:37:37 FILE NAME: WS003

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.0

C U L V	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	494.80	494.70	80.00	1 ICMP	13.50	8.50	.033	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: WS003 DATE: 10-17-1993

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
499.10	0	0	0	0	0	0	0	0	[illegible]
499.77	130	130	0	0	0	0	0	0	[illegible]
500.30	260	260	0	0	0	0	0	0	[illegible]
501.96	390	390	0	0	0	0	0	0	[illegible]
503.40	520	520	0	0	0	0	0	0	[illegible]
504.13	650	592	0	0	0	0	0	57	[illegible]
504.42	780	614	0	0	0	0	0	160	8
504.59	910	628	0	0	0	0	0	278	7
504.71	1040	632	0	0	0	0	0	[illegible]	6
504.79	1170	645	0	0	0	0	0	[illegible]	[illegible]
504.87	1300	650	0	0	0	0	0	[illegible]	[illegible]
[illegible]	[illegible]	534	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: WS003 DATE: 10-17-1993

HEAD ELEV (FT)	HEAD ERROR (FT)	TOTAL FLOW (CFS)	FLOW ERROR (CFS)	% FLOW ERROR
499.10	0.00	0	0	0.00
499.77	0.00	130	[illegible]	[illegible]
500.30	0.00	260	0	0.00
501.96	0.00	390	0	0.00
503.40	0.00	520	0	[illegible]
504.13	[illegible]	650	[illegible]	[illegible]
504.42	-0.10	780	[illegible]	[illegible]
504.59	-0.0[illegible]	910	8	1.04
504.71	-0.0[illegible]	1040	[illegible]	[illegible]
504.79	-0.0[illegible]	1170	[illegible]	[illegible]
504.87	-0.01	1300	10	[illegible]

1) TOLERANCE (FT) = 0.010 2) TOLERANCE (%) = 1.000

CURRENT DATE: 10-18-1993 FILE DATE: 10-1[illegible]
CURRENT TIME: [illegible]:07:37 FILE NAME: [illegible]

PERFORMANCE CURVE FOR CULVERT # 1 - 1 (13.5 BY [illegible]) [illegible]

DIS- CHARGE FLOW (cfs)	HEAD- WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	499.60	0.00	4.80	0-NF	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]
130	499.77	3.46	4.97	3-M1t	3.66	1.40	2.10	4.90	[illegible]	[illegible]
260	500.30	5.50	[illegible]	3-M2t	7.00	2.27	4.07	[illegible]	[illegible]	[illegible]
390	501.91	7.15	[illegible]	6-FFn	8.50	2.99	4.40	[illegible]	[illegible]	[illegible]
520	503.40	8.60	7.18	6-FFn	8.50	3.64	5.07	[illegible]	[illegible]	[illegible]
592	504.18	9.38	7.70	6-FFn	8.50	3.97	6.38	[illegible]	[illegible]	[illegible]
614	504.42	9.62	7.87	6-FFn	8.50	4.07	6.72	8.50	[illegible]	4.90
628	504.58	9.78	7.98	6-FFn	8.50	4.13	7.08	8.50	[illegible]	[illegible]
639	504.71	9.91	8.06	6-FFn	8.50	4.18	7.20	8.50	[illegible]	4.90
643	504.79	9.99	8.12	6-FFn	8.50	4.21	7.28	8.50	0.00	4.90
652	504.87	10.07	8.18	6-FFn	8.50	4.24	7.35	8.50	0.00	4.90

El. inlet face invert 494.80 ft El. outlet invert 494.70 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	0.00
INLET ELEVATION (FT)	494.80
OUTLET STATION (FT)	68.00
OUTLET ELEVATION (FT)	494.70
NUMBER OF BARRELS	1
SLOPE (V-FT/H-FT)	0.0015
CULVERT LENGTH ALONG SLOPE (FT)	68.00

***** CULVERT FILE [illegible] ******************
BARREL SHAPE USER DEFINED
BARREL SPAN [illegible] FT
BARREL [illegible]
[illegible]
BARREL [illegible] [illegible] SIDES [illegible]
[illegible]
INLET TYPE [illegible]
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

CURRENT DATE: 10-12-1993 FILE DATE: 10-12-1993
CURRENT TIME: 01:27:39 FILE NAME: WSPRO

*****

***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDINATE NUMBER	X (FT)	Y-TOP (FT)	Y-BOTTOM (FT)
1	0.00	3.00	0.00
2	0.84	1.12	0.00
3	1.67	0.42	0.00
4	2.53	0.04	0.00
5	3.35	0.36	0.00
6	4.20	0.82	0.00
7	5.04	0.22	0.00
8	5.91	0.43	0.00
9	6.75	0.50	0.00
10	7.59	0.43	0.00
11	8.44	0.23	0.00
12	9.28	0.55	0.00
13	10.13	0.36	0.00
14	10.97	1.04	0.00
15	11.81	0.42	0.00
16	12.66	1.12	0.00
17	13.50	3.00	0.00

CURRENT DATE: 10-18-1993　　　　FILE DATE: 10-17-1993
CURRENT TIME: 01:37:39　　　　FILE NAME: [illegible]

TAILWATER

CONSTANT WATER SURFACE ELEVATION
479.60

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE　　　　GRAVEL
EMBANKMENT TOP WIDTH (FT)　　　　35.00
%%%% USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X (FT)	Y (FT)
1	0.00	507.40
2	95.00	505.00
3	220.00	504.50
4	290.00	504.60
5	[illegible]	504.60
6	320.00	504.60
7	465.00	504.70
8	650.00	[illegible]
9	720.00	503.90
10	760.00	504.30
11	910.00	505.30
12	1010.00	[illegible]

Appendix D

```
1  ¡¡¡¡¡¡¡¡¡¡¡¡¡¡80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡

'DT TR-20
'I  E   1 West Boggs Lake - 100 year 24 hour storm hydrograph for the          1
:ITLE     area 1 lake drainage area. Assuaptions = starting elev. =499.6
3 STRUCT       1
3                              495.0         0.0         0.0
3                              496.0        0.01        0.95
3                              497.0        0.02        3.23
3                              498.0        0.03        6.92
3                              499.0        0.04       11.95
3                              499.6        0.05       15.78
3                              500.0        0.06       18.33
3                              500.8        0.07       27.35
3                             500.91       130.0       28.59
3                             501.22       260.0       33.35
3                             501.96       390.0       45.95
3                              503.4       520.0       75.62
3                             504.18       650.0       94.25
3                             504.42       780.0      100.59
3                             504.59       910.0      105.08
3                             504.71      1040.0      108.26
3                             504.79      1170.0      110.37
3
3 STRUCT       2
3                              499.6         0.0         0.0
3                              500.1        10.0       250.0
3                              500.6        40.0       650.0
3                              501.1       110.0      1100.0
3                              501.6       200.0      1450.0
3                              502.1       260.0      1850.0
3                              502.6       310.0      2200.0
3                              503.1       380.0      2800.0
3                              503.6       400.0      3000.0
3                              504.1       600.0      3400.0
3                              504.6      1100.0      3800.0
3                              505.1      1800.0      4350.0
3 HDTBL
. RUNOFF 1     1      1         1.97        79.0        2.011 1   1 1 1
:  RESVOR 2    1 1    2       499.6                         1 1 1 1 1 1
:  RUNOFF 1    2      3        11.34        79.0        2.771 1   1 1 1
5 ADDHYD 4     2 2 3 4                                     1 1 1 1 1 1
5 RESVOR 2     2 4    5       499.6                         1 1 1 1 1 1
  HDATA
7 INCREM 6                     0.25
8 COMPUT 7     1      2         0.0        6.31        1.02 2   1   1
  HDCMP 1
 HDJOB 2
```

FILE NO. 1

COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

THE USERS MANUAL FOR THIS PROGRAM IS THE MAY 1982 DRAFT OF TR-20. CHANGES FROM THE 2/14/74 VERSION INCLUDE:

REACH ROUTING - THE MODIFIED ATT-KIN ROUTING PROCEDURE REPLACES THE CONVEX METHOD. INPUT DATA PREPARED FOR PREVIOUS PROGRAM VERSIONS USING CONVEX ROUTING COEFFICIENTS WILL NOT RUN ON THIS VERSION.

THE PREFERRED TYPE OF DATA ENTRY IS CROSS SECTION DATA REPRESENTATIVE OF A REACH. IT IS RECOMMENDED THAT THE OPTIONAL CROSS SECTION DISCHARGE-AREA PLOTS BE OBTAINED WHENEVER NEW CROSS SECTION DATA IS ENTERED. THE PLOTS SHOULD BE CHECKED FOR REASONABLENESS AND ADEQUACY OF INPUT DATA FOR THE COMPUTATION OF "M" VALUES USED IN THE ROUTING PROCEDURE.

GUIDELINES FOR DETERMINING OR ANALYZING REACH LENGTHS AND COEFFICIENTS (X,M) ARE AVAILABLE IN THE USERS MANUAL. SUMMARY TABLE 2 DISPLAYS REACH ROUTING RESULTS AND ROUTING PARAMETERS FOR COMPARISON AND CHECKING.

HYDROGRAPH GENERATION - THE PROCEDURE TO CALCULATE THE INTERNAL TIME INCREMENT AND PEAK TIME OF THE UNIT HYDROGRAPH HAVE BEEN IMPROVED. PEAK DISCHARGES AND TIMES MAY DIFFER FROM THE PREVIOUS VERSION. OUTPUT HYDROGRAPHS ARE STILL INTERPOLATED, PRINTED, AND ROUTED AT THE USER SELECTED MAIN TIME INCREMENT.

INTERMEDIATE PEAKS - METHOD ADDED TO PROVIDE DISCHARGES AT INTERMEDIATE POINTS WITHIN REACHES WITHOUT ROUTING.

OTHER - THIS VERSION CONTAINS SOME ADDITIONS TO THE INPUT AND NUMEROUS MODIFICATIONS TO THE OUTPUT. USER OPTIONS HAVE BEEN MODIFIED AND AUGMENTED ON THE JOB RECORD, RAINTABLES ADDED, ERROR AND WARNING MESSAGES EXPANDED, AND THE SUMMARY TABLES COMPLETELY REVISED. THE HOLDOUT OPTION IS NOT OPERATIONAL AT THIS TIME.

PROGRAM QUESTIONS OR PROBLEMS SHOULD BE DIRECTED TO HYDRAULIC ENGINEERS AT THE SCS NATIONAL TECHNICAL CENTERS:

CHESTER, PA (NORTHEAST) -- 215-499-3933, FORT WORTH, TX (SOUTH) -- 334-5242 (FTS)
LINCOLN, NB (MIDWEST) -- 541-5316 (FTS), PORTLAND, OR (WEST) -- 423-4039 (FTS)
OR HYDROLOGY UNIT, ENGINEERING DIVISION, LANHAM, MD -- 436-7383 (FTS).

PROGRAM CHANGES SINCE MAY 1982:

12/17/82 - CORRECT PEAK RATE FACTOR FOR USER ENTERED DIMHYD
CORRECT REACH ROUTING PEAK TRAVEL TIME PRINTED WITH FULLPRINT OPTION
5/02/83 - CORRECT COMPUTATIONS FOR ---
1. DIVISION OF BASEFLOW IN DIVERT OPERATION
2. HYDROGRAPH VOLUME SPLIT BETWEEN BASEFLOW AND ABOVE BASEFLOW
3. CROSS SECTION DATA PLOTTING POSITION
4. INTERMEDIATE PEAK WHEN "FROM" AREA IS LARGER THAN "THRU" AREA
5. STORAGE ROUTED REACH TRAVEL TIME FOR MULTIPEAK HYDROGRAPH
6. ORDERING "FLOW-FREQ" FILE FROM SUMMARY TABLE #3 DATA
7. BASEFLOW ENTERED WITH READHYD
8. LOW FLOW SPLIT DURING DIVERT PROCEDURE #2 WHEN SECTION RATINGS START AT DIFFERENT ELEVATIONS
ENHANCEMENTS ---
1. REPLACE USER MANUAL ERROR CODES (PAGE 4-9 TO 4-11) WITH MESSAGES
2. LABEL OUTPUT HYDROGRAPH FILES WITH CROSS SECTION/STRUCTURE, ALTERNATE AND STORM NO'S
09/01/83 - CORRECT INPUT AND OUTPUT ERRORS FOR INTERMEDIATE PEAKS
CORRECT COMBINATION OF RATING TABLES FOR DIVERT

ELIMINATE MINIMUM REACH TRAVEL TIME WHEN ATT-KIN COEFFICIENT EQUALS ONE

R.. XEQ 11/16/93 West Boggs Lake - 100 year 24 hour storm hydrograph for the 1 JOB 1 PASS 1
REV 09/01/83 area 1 lake drainage area. Assuaptions = starting elev. =499.6 PAGE 2

EX UTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = .25 HOURS RECORD ID

EX UTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO STRUCTURE 2 RECORD ID
STARTING TIME = .00 RAIN DEPTH = 6.31 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = .25 HOURS

PERATION RUNOFF STRUCTURE 1

PEAK TIME(HRS) PEAK DISCHARGE(CFS) PEAK ELEVATION(FEET)
13.17 1525.13 (RUNOFF)

(HRS)		FIRST HYDROGRAPH POINT = .00 HOURS				TIME INCREMENT = .25 HOURS			DRAINAGE AREA = 1.93 SQ.MI.		
.00	DISCHG	.00	.00	.00	.00	.00	.01	.05	.21	.60	1.36
7.50	DISCHG	2.59	4.30	6.41	8.91	11.86	15.38	19.58	24.46	30.00	36.23
.00	DISCHG	43.18	50.96	59.87	70.70	84.71	103.68	131.47	195.81	357.57	635.83
[illegible]	DISCHG	999.80	1321.90	1498.64	1518.36	1417.96	1236.29	1025.00	846.89	709.46	599.61
15.00	DISCHG	507.44	435.13	376.21	328.94	291.45	261.80	237.95	219.18	204.03	191.41
17.50	DISCHG	180.53	170.97	162.10	153.71	145.93	139.51	133.62	128.44	124.12	120.72
.00	DISCHG	117.84	114.86	111.33	107.15	102.73	98.56	94.93	92.05	89.97	88.49
22.50	DISCHG	87.42	86.64	86.08	85.67	85.39	85.09	84.26	81.96	77.08	69.11
25.00	DISCHG	58.68	47.29	36.40	27.01	19.69	14.48	10.71	7.90	5.81	4.25
.50	DISCHG	3.12	2.28	1.65	1.19	.85	.60	.41	.28	.17	.10
.00	DISCHG	.04	.01	.00							

UNOFF VOLUME ABOVE BASEFLOW = 3.95 WATERSHED INCHES, 4917.94 CFS-HRS, 406.42 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

L..ATION RESVOR STRUCTURE 1

PEAK TIME(HRS) PEAK DISCHARGE(CFS) PEAK ELEVATION(FEET)
13.77 1280.50 504.86

IME(HRS)		FIRST HYDROGRAPH POINT = .00 HOURS				TIME INCREMENT = .25 HOURS			DRAINAGE AREA = 1.93 SQ.MI.		
.00	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
2.50	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.00	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
[illegible]	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
	DISCHG	.05	.05	.05	.05	.05	.05	.05	.06	.06	.06
.50	ELEV	499.61	499.62	499.63	499.66	499.69	499.74	499.79	499.86	499.95	500.03
10.00	DISCHG	.06	.06	.06	.07	.07	.07	81.52	145.62	203.30	291.70
10.00	ELEV	500.11	500.19	500.29	500.41	500.56	500.73	500.87	500.95	501.08	501.40

12.50	DISCHG	391.37	458.01	551.81	729.20	1111.89	1279.31	1163.67	999.18	877.38	776.03
13.50	ELEV	501.98	502.71	503.59	504.33	504.75	504.86	504.79	504.67	504.55	504.41
.00	DISCHG	698.24	638.04	606.79	572.60	537.31	508.56	486.15	463.84	442.00	420.84
15.00	ELEV	504.27	504.11	503.92	503.72	503.50	503.27	503.03	502.78	502.54	502.30
17.50	DISCHG	400.50	370.06	330.85	297.54	269.08	225.13	186.15	161.89	146.22	135.75
.50	ELEV	502.08	501.85	501.62	501.43	501.27	501.14	501.04	500.99	500.95	500.92
20.00	DISCHG	126.45	115.96	112.99	109.09	104.78	100.48	96.60	93.37	90.92	89.16
20.00	ELEV	500.91	500.90	500.90	500.89	500.89	500.89	500.88	500.88	500.88	500.88
22.50	DISCHG	87.90	86.99	86.33	85.86	85.52	85.23	84.85	83.05	79.38	72.85
.50	ELEV	500.87	500.87	500.87	500.87	500.87	500.87	500.87	500.87	500.87	500.86
25.00	DISCHG	63.54	52.56	41.42	31.32	23.04	16.85	12.43	9.18	6.76	4.97
25.00	ELEV	500.85	500.84	500.83	500.83	500.82	500.81	500.81	500.81	500.81	500.80
.50	DISCHG	3.64	2.66	1.94	1.40	1.01	.72	.50	.34	.22	.13
27.50	ELEV	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80
30.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.00	ELEV	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80
.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
32.50	ELEV	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80
35.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
[illegible]	ELEV	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80
37.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
37.50	ELEV	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80	500.80
.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
40.00	ELEV	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79
42.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.50	ELEV	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79
.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
45.00	ELEV	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79
47.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.50	ELEV	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79
50.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
50.00	ELEV	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79
.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
52.50	ELEV	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79
55.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.00	ELEV	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79
.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
57.50	ELEV	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.79	500.78	500.78
60.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.00	ELEV	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78
62.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
62.50	ELEV	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78
.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
65.00	ELEV	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78
67.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
[illegible]	ELEV	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78
.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
70.00	ELEV	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78	500.78
72.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07

72.50 ELEV 500.78 500.78 500.78 500.78 500.78 500.78 500.78 500.78 500.78 500.78

RUNOFF VOLUME ABOVE BASEFLOW = 3.83 WATERSHED INCHES, 4774.60 CFS-HRS, 394.57 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

OPERATION RUNOFF STRUCTURE 2

PEAK TIME(HRS) 13.72 PEAK DISCHARGE(CFS) 7091.44 PEAK ELEVATION(FEET) (RUNOFF)

TIME (HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .25 HOURS DRAINAGE AREA = 11.34 SQ.MI.

.00	DISCHG	.00	.00	.00	.00	.00	.01	.12	.53	1.54	3.57
7.50	DISCHG	7.05	12.31	19.53	28.87	40.55	54.78	71.87	92.20	115.87	143.20
.00	DISCHG	174.32	209.61	250.17	298.10	356.80	431.59	541.84	770.07	1226.60	1971.15
.50	DISCHG	3009.31	4284.03	5502.49	6442.76	6962.68	7088.93	6880.79	6419.87	5760.98	5012.95
15.00	DISCHG	4344.11	3791.86	3328.41	2934.74	2594.18	2304.54	2061.80	1857.68	1685.27	1539.91
17.50	DISCHG	1418.00	1315.01	1225.99	1148.80	1080.52	1018.62	962.59	912.08	868.43	830.67
	DISCHG	798.26	765.97	732.86	702.24	673.16	646.82	622.72	600.52	580.75	563.73
22.50	DISCHG	549.63	538.56	530.00	523.25	517.93	513.65	509.30	501.77	488.27	465.77
25.00	DISCHG	432.26	389.23	340.55	290.16	241.38	196.60	157.51	125.24	99.85	79.97
.50	DISCHG	64.06	51.25	40.87	32.59	25.96	20.66	16.46	13.09	10.41	8.25
.00	DISCHG	6.51	5.10	3.97	3.05	2.32	1.74	1.27	.89	.57	.33
32.50	DISCHG	.15	.04	.00							

RUNOFF VOLUME ABOVE BASEFLOW = 3.96 WATERSHED INCHES, 28968.52 CFS-HRS, 2393.96 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 2, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

OPERATION ADDHYD STRUCTURE 2

PEAK TIME(HRS) 13.74 PEAK DISCHARGE(CFS) 8368.43 PEAK ELEVATION(FEET) 509.79

TIME (HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .25 HOURS DRAINAGE AREA = 13.27 SQ.MI.

.00	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.50	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
7.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
15.00	DISCHG	.05	.05	.05	.05	.05	.06	.17	.58	1.59	3.62
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.61	499.63	499.68	499.78
.50	DISCHG	7.10	12.36	19.58	28.92	40.60	54.83	71.92	92.25	115.93	143.26
7.50	ELEV	499.96	500.14	500.26	500.42	500.60	500.71	500.83	500.97	501.13	501.28
	DISCHG	174.38	209.67	250.23	298.16	356.87	431.86	623.36	915.69	1429.90	2262.86
.00	ELEV	501.46	501.68	502.02	502.48	502.93	503.68	504.12	504.42	504.84	505.43
12.50	DISCHG	3400.69	4722.05	6054.30	7171.95	8074.57	8368.24	8044.46	7419.05	6638.37	5783.98
12.50	ELEV	506.24	507.19	508.14	508.94	509.58	509.79	509.56	509.11	508.56	507.95

15.00	DISCHG	5042.35	4429.89	3935.20	3507.35	3131.50	2813.10	2547.95	2321.52	2127.27	1960.75
.00	ELEV	507.42	506.98	506.63	506.32	506.05	505.82	505.63	505.47	505.33	505.21
.50	DISCHG	1818.50	1685.06	1556.84	1446.33	1349.60	1263.95	1148.74	1073.97	1014.65	966.41
17.50	ELEV	505.11	505.02	504.93	504.85	504.78	504.70	504.63	504.57	504.51	504.47
.00	DISCHG	922.72	879.94	845.87	811.33	777.93	747.30	719.32	693.89	671.67	652.89
.00	ELEV	504.42	504.38	504.35	504.31	504.28	504.25	504.22	504.19	504.17	504.15
22.50	DISCHG	637.54	625.55	616.33	609.11	603.45	598.88	593.95	584.82	567.64	536.61
.50	ELEV	504.14	504.13	504.12	504.11	504.10	504.10	504.08	504.06	504.02	503.95
.00	DISCHG	495.80	441.79	381.97	321.50	264.42	213.46	169.94	134.42	106.62	84.94
25.00	ELEV	503.84	503.70	503.15	502.66	502.14	501.71	501.43	501.24	501.08	500.92
27.50	DISCHG	67.70	53.91	42.81	33.99	26.97	21.38	16.96	13.43	10.63	8.38
.50	ELEV	500.80	500.70	500.62	500.50	500.38	500.29	500.22	500.16	500.11	500.02
.00	DISCHG	6.58	5.17	4.04	3.12	2.39	1.81	1.34	.96	.64	.40
30.00	ELEV	499.93	499.86	499.80	499.76	499.72	499.69	499.67	499.65	499.63	499.62
32.50	DISCHG	.22	.11	.07	.07	.07	.07	.07	.07	.07	.07
.50	ELEV	499.61	499.61	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
35.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
35.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
[illegible]	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
[illegible]	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
40.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
42.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
45.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
47.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
47.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
50.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
52.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
55.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
57.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
60.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
60.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
62.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
65.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
67.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
70.00	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
72.50	DISCHG	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
72.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60

RUNOFF VOLUME ABOVE BASEFLOW = 3.94 WATERSHED INCHES, 33743.14 CFS-HRS, 2788.53 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 2, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

DETENTION RESVOR STRUCTURE 2

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
25.61	354.82	502.92

TIME(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .25 HOURS DRAINAGE AREA = 13.27 SQ.MI.

.50	DISCHG	.01	.02	.03	.05	.08	.12	.17	.24	.32	.43	
7.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.61	499.61	499.61	499.62	499.62	
10.00	DISCHG	.56	.72	.91	1.13	1.40	1.73	2.16	2.80	3.76	5.29	
1.00	ELEV	499.63	499.64	499.65	499.66	499.67	499.69	499.71	499.74	499.79	499.86	
..50	DISCHG	7.62	11.82	20.14	30.35	44.37	70.61	96.71	128.51	165.08	197.13	
12.50	ELEV	499.98	500.13	500.27	500.44	500.63	500.82	501.01	501.20	501.41	501.58	
00	DISCHG	214.47	228.46	240.70	251.47	260.92	268.91	276.01	282.38	288.10	293.28	
[illegible]	ELEV	501.72	501.84	501.94	502.03	502.11	502.19	502.26	502.32	502.38	502.43	
17.50	DISCHG	297.98	302.26	306.15	309.67	313.53	317.08	320.25	323.11	325.71	328.11	
17.50	ELEV	502.48	502.52	502.56	502.60	502.63	502.65	502.67	502.69	502.71	502.73	
.00	DISCHG	330.33	332.39	334.31	336.09	337.75	339.28	340.70	342.02	343.25	344.41	
20.00	ELEV	502.75	502.76	502.77	502.79	502.80	502.81	502.82	502.83	502.84	502.85	
22.50	DISCHG	345.49	346.52	347.51	348.47	349.40	350.31	351.20	352.06	352.87	353.59	
.50	ELEV	502.85	502.86	502.87	502.87	502.88	502.89	502.89	502.90	502.91	502.91	
..00	DISCHG	354.18	354.57	354.80	354.79	354.57	354.15	353.56	352.84	352.00	351.07	
25.00	ELEV	502.92	502.92	502.92	502.92	502.92	502.92	502.91	502.91	502.90	502.89	
.50	DISCHG	350.06	349.04	347.95	346.84	345.69	344.53	343.36	342.17	340.98	339.79	
.50	ELEV	502.89	502.88	502.87	502.86	502.85	502.85	502.84	502.83	502.82	502.81	
30.00	DISCHG	338.59	337.39	336.18	334.98	333.79	332.59	331.39	330.20	329.01	327.83	
30.00	ELEV	502.80	502.80	502.79	502.78	502.77	502.76	502.75	502.74	502.74	502.73	
.50	DISCHG	326.65	325.47	324.29	323.12	321.96	320.79	319.64	318.48	317.33	316.19	
..50	ELEV	502.72	502.71	502.70	502.69	502.69	502.68	502.67	502.66	502.65	502.64	
35.00	DISCHG	315.05	313.91	312.78	311.65	310.53	309.51	308.60	307.69	306.79	305.88	
.00	ELEV	502.64	502.63	502.62	502.61	502.60	502.60	502.59	502.58	502.57	502.56	
. .50	DISCHG	304.98	304.08	303.19	302.29	301.40	300.51	299.63	298.75	297.87	296.99	
37.50	ELEV	502.55	502.54	502.53	502.52	502.51	502.51	502.50	502.49	502.48	502.47	
.00	DISCHG	296.11	295.24	294.37	293.50	292.64	291.78	290.92	290.06	289.20	288.35	
. .00	ELEV	502.46	502.45	502.44	502.44	502.43	502.42	502.41	502.40	502.39	502.38	
42.50	DISCHG	287.50	286.66	285.81	284.97	284.13	283.29	282.46	281.62	280.80	279.97	
42.50	ELEV	502.38	502.37	502.36	502.35	502.34	502.33	502.32	502.32	502.31	502.30	
. .00	DISCHG	279.14	278.32	277.50	276.68	275.87	275.05	274.24	273.44	272.63	271.83	
45.00	ELEV	502.29	502.28	502.27	502.27	502.26	502.25	502.24	502.23	502.23	502.22	
4 ..	DISCHG	271.03	270.23	269.43	268.64	267.85	267.06	266.27	265.49	264.70	263.92	
. .00	ELEV	502.21	502.20	502.19	502.19	502.18	502.17	502.16	502.15	502.15	502.14	
9 00	DISCHG	263.15	262.37	261.60	260.83	260.06	259.26	258.45	257.65	256.86	256.06	
50.00	ELEV	502.13	502.12	502.12	502.11	502.10	502.09	502.09	502.08	502.07	502.07	
5 50	DISCHG	255.27	254.48	253.69	252.91	252.13	251.35	250.57	249.79	249.02	248.25	

52.50	ELEV	502.06	502.05	502.05	502.04	502.03	502.03	502.02	502.01	502.01	502.00
55.00	DISCHG	247.48	246.72	245.95	245.19	244.43	243.68	242.92	242.17	241.42	240.68
5.00	ELEV	502.00	501.99	501.98	501.98	501.97	501.96	501.96	501.95	501.95	501.94
57.50	DISCHG	239.93	239.19	238.45	237.71	236.98	236.24	235.51	234.79	234.06	233.33
57.50	ELEV	501.93	501.93	501.92	501.91	501.91	501.90	501.90	501.89	501.88	501.88
0.00	DISCHG	232.61	231.89	231.18	230.46	229.75	229.04	228.33	227.62	226.92	226.22
0.00	ELEV	501.87	501.87	501.86	501.85	501.85	501.84	501.84	501.83	501.82	501.82
62.50	DISCHG	225.52	224.82	224.12	223.43	222.74	222.05	221.36	220.66	220.00	219.32
2.50	ELEV	501.81	501.81	501.80	501.80	501.79	501.78	501.78	501.77	501.77	501.76
5.00	DISCHG	218.64	217.96	217.29	216.61	215.94	215.28	214.61	213.95	213.28	212.62
65.00	ELEV	501.76	501.75	501.74	501.74	501.73	501.73	501.72	501.72	501.71	501.71
67.50	DISCHG	211.97	211.31	210.66	210.01	209.36	208.71	208.06	207.42	206.78	206.14
7.50	ELEV	501.70	501.69	501.69	501.68	501.68	501.67	501.67	501.66	501.66	501.65
70.00	DISCHG	205.50	204.86	204.23	203.60	202.97	202.34	201.72	201.09	200.47	199.74
70.00	ELEV	501.65	501.64	501.64	501.63	501.62	501.62	501.61	501.61	501.60	501.60
2.50	DISCHG	198.68	197.63	196.59	195.54	194.51	193.48	192.45	191.43	190.42	189.41
5.00	ELEV	501.59	501.59	501.58	501.58	501.57	501.56	501.56	501.55	501.55	501.54

RUNOFF VOLUME ABOVE BASEFLOW = 1.95 WATERSHED INCHES, 16703.25 CFS-HRS, 1380.36 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 2, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 1 RECORD ID

EXECUTIVE CONTROL OPERATION ENDJOB RECORD ID

UMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

TION/ JCTURE ID	STANDARD CONTROL OPERATION		DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 1														
CTURE	1	RUNOFF	1.93	2	2	.25	.0	6.31	24.00	3.95	---	13.17	1525.13	790.2
UCTURE	1	RESVOR	1.93	2	2	.25	.0	6.31	24.00	3.83	504.86	13.77	1280.50	663.5
RUCTURE	2	RUNOFF	11.34	2	2	.25	.0	6.31	24.00	3.96	---	13.72	7091.44	625.3
CTURE	2	ADDHYD	13.27	2	2	.25	.0	6.31	24.00	3.94	509.79	13.74	8368.43	630.6
CTURE	2	RESVOR	13.27	2	2	.25	.0	6.31	24.00	1.95	502.92	25.61	354.82	26.7

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

SECTION/ STRUCTURE / ALTERNATE	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
STRUCTURE 2	13.27	
ALTERNATE 1		354.82
STRUCTURE 1	1.93	
ALTERNATE 1		1280.50

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1*  ***************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*********************

 JOB TR-20
 TITLE   1 West Boggs Lake - 100 year 24 hour storm hydrograph for the          1
 TITLE     area 1 lake drainage area. Assumptions = starting elev. =499.6
 3 STRUCT       1
 8                                495.0          0.0          0.0
 8                                496.0         0.01         0.95
 8                                497.0         0.02         3.23
 8                                498.0         0.03         6.92
 8                                499.0         0.04        11.95
 8                                499.6         0.05        15.78
 8                                500.0         0.06        18.33
 8                                500.8         0.07        27.35
 8                                502.0         0.08        46.83
 8                               502.32         48.0        52.95
 8                               502.52         77.0        56.89
 8                               502.82        155.0        63.01
 8                                503.8        494.0        84.87
 8                               504.18        650.0        94.25
 8                               504.42        780.0       100.59
 8                               504.59        910.0       105.08
 8                               504.71       1040.0       108.26
 8                               504.79       1170.0       110.37
 9 ENDTBL
 3 STRUCT       2
 8                                499.6          0.0          0.0
 8                                500.1         10.0        250.0
 8                                500.6         40.0        650.0
 8                                501.1        110.0       1100.0
 8                                501.6        200.0       1450.0
 8                                502.1        260.0       1850.0
 8                                502.6        310.0       2200.0
 8                                503.1        380.0       2600.0
 8                                503.6        400.0       3000.0
 8                                504.1        600.0       3400.0
 8                                504.6       1100.0       3800.0
 9 ENDTBL
 5 RUNOFF 1      1     1          1.93         79.0        2.011 1   1 1 1
 5 RESVOR 2      1 1   2         497.6                        1 1 1 1 1 1
 5 JUNOFF 1      2     3         11.34         79.0        2.771 1   1 1 1
 5 HYDHYD 4      2 2 3 4                                      1 1 1 1 1 1
 5 RESVOR 2      2 4   5         499.6                        1 1 1 1 1 1
   IDATA
 7 INCREM 6                      0.25
 7 COMPUT 7      1     2          0.0         6.31         1.02 2   1   1
   IDCMP 1
   IDJOB 2
```

FILE NO. 1

COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

THE USERS MANUAL FOR THIS PROGRAM IS THE MAY 1982 DRAFT OF TR-20. CHANGES FROM THE 2/14/74 VERSION INCLUDE:

REACH ROUTING - THE MODIFIED ATT-KIN ROUTING PROCEDURE REPLACES THE CONVEX METHOD. INPUT DATA PREPARED FOR PREVIOUS PROGRAM VERSIONS USING CONVEX ROUTING COEFFICIENTS WILL NOT RUN ON THIS VERSION.

THE PREFERRED TYPE OF DATA ENTRY IS CROSS SECTION DATA REPRESENTATIVE OF A REACH. IT IS RECOMMENDED THAT THE OPTIONAL CROSS SECTION DISCHARGE-AREA PLOTS BE OBTAINED WHENEVER NEW CROSS SECTION DATA IS ENTERED. THE PLOTS SHOULD BE CHECKED FOR REASONABLENESS AND ADEQUACY OF INPUT DATA FOR THE COMPUTATION OF "M" VALUES USED IN THE ROUTING PROCEDURE.

GUIDELINES FOR DETERMINING OR ANALYZING REACH LENGTHS AND COEFFICIENTS (X,K) ARE AVAILABLE IN THE USERS MANUAL. SUMMARY TABLE 2 DISPLAYS REACH ROUTING RESULTS AND ROUTING PARAMETERS FOR COMPARISON AND CHECKING.

HYDROGRAPH GENERATION - THE PROCEDURE TO CALCULATE THE INTERNAL TIME INCREMENT AND PEAK TIME OF THE UNIT HYDROGRAPH HAVE BEEN IMPROVED. PEAK DISCHARGES AND TIMES MAY DIFFER FROM THE PREVIOUS VERSION. OUTPUT HYDROGRAPHS ARE STILL INTERPOLATED, PRINTED, AND ROUTED AT THE USER SELECTED MAIN TIME INCREMENT.

INTERMEDIATE PEAKS - METHOD ADDED TO PROVIDE DISCHARGES AT INTERMEDIATE POINTS WITHIN REACHES WITHOUT ROUTING.

OTHER - THIS VERSION CONTAINS SOME ADDITIONS TO THE INPUT AND NUMEROUS MODIFICATIONS TO THE OUTPUT. USER OPTIONS HAVE BEEN MODIFIED AND AUGMENTED ON THE JOB RECORD, RAINTABLES ADDED, ERROR AND WARNING MESSAGES EXPANDED, AND THE SUMMARY TABLES COMPLETELY REVISED. THE HOLDOUT OPTION IS NOT OPERATIONAL AT THIS TIME.

PROGRAM QUESTIONS OR PROBLEMS SHOULD BE DIRECTED TO HYDRAULIC ENGINEERS AT THE SCS NATIONAL TECHNICAL CENTERS:

CHESTER, PA (NORTHEAST) -- 215-499-3933, FORT WORTH, TX (SOUTH) -- 334-5242 (FTS)
LINCOLN, NB (MIDWEST) -- 541-5318 (FTS), PORTLAND, OR (WEST) -- 423-4099 (FTS)
OR HYDROLOGY UNIT, ENGINEERING DIVISION, LANHAM, MD -- 436-7383 (FTS).

PROGRAM CHANGES SINCE MAY 1982:

12/17/82 - CORRECT PEAK RATE FACTOR FOR USER ENTERED DIMHYD
CORRECT REACH ROUTING PEAK TRAVEL TIME PRINTED WITH FULLPRINT OPTION
5/02/83 - CORRECT COMPUTATIONS FOR ---
1. DIVISION OF BASEFLOW IN DIVERT OPERATION
2. HYDROGRAPH VOLUME SPLIT BETWEEN BASEFLOW AND ABOVE BASEFLOW
3. CROSS SECTION DATA PLOTTING POSITION
4. INTERMEDIATE PEAK WHEN "FROM" AREA IS LARGER THAN "THRU" AREA
5. STORAGE ROUTED REACH TRAVEL TIME FOR MULTIPEAK HYDROGRAPH
6. ORDERING "FLOW-FREQ" FILE FROM SUMMARY TABLE #3 DATA
7. BASEFLOW ENTERED WITH READHYD
8. LOW FLOW SPLIT DURING DIVERT PROCEDURE #2 WHEN SECTION RATINGS START AT DIFFERENT ELEVATIONS
ENHANCEMENTS ---
1. REPLACE USER MANUAL ERROR CODES (PAGE 4-9 TO 4-11) WITH MESSAGES
2. LABEL OUTPUT HYDROGRAPH FILES WITH CROSS SECTION/STRUCTURE, ALTERNATE AND STORM NO'S
09/01/83 - CORRECT INPUT AND OUTPUT ERRORS FOR INTERMEDIATE PEAKS
CORRECT COMBINATION OF RATING TABLES FOR DIVERT

ELIMINATE MINIMUM REACH TRAVEL TIME WHEN ATT-KIN COEFFICIENT EQUALS ONE

TF : XEQ 11/16/93 West Boggs Lake - 100 year 24 hour storm hydrograph for the 1 JOB 1 PASS 1
REV 09/01/83 area 1 lake drainage area. Assumptions = starting elev. =499.6 PAGE 2

EX UTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = .25 HOURS RECORD ID

EX UTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO STRUCTURE 2 RECORD ID
STARTING TIME = .00 RAIN DEPTH = 6.31 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = .25 HOURS

PEKATION RUNOFF STRUCTURE 1

PEAK TIME(HRS) PEAK DISCHARGE(CFS) PEAK ELEVATION(FEET)
13.17 1525.13 (RUNOFF)

I (HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .25 HOURS DRAINAGE AREA = 1.93 SQ.MI.

.00	DISCHG	.00	.00	.00	.00	.00	.01	.05	.21	.60	1.36
7.50	DISCHG	2.59	4.30	6.41	8.91	11.86	15.38	19.58	24.46	30.00	36.23
10.00	DISCHG	43.18	50.96	59.87	70.70	84.71	103.68	131.47	195.61	387.57	635.83
[illegible]	DISCHG	999.80	1321.90	1498.64	1518.36	1417.96	1236.29	1025.00	846.89	709.46	599.61
15.00	DISCHG	507.44	435.13	376.21	328.94	291.45	261.60	237.95	219.18	204.03	191.41
17.50	DISCHG	180.53	170.97	162.10	153.71	145.93	139.51	133.62	128.44	124.12	120.72
.00	DISCHG	117.84	114.88	111.33	107.15	102.73	98.56	94.93	92.05	89.97	88.49
.50	DISCHG	87.42	86.64	86.08	85.67	85.39	85.09	84.26	81.96	77.06	69.11
25.00	DISCHG	58.68	47.29	36.40	27.01	19.69	14.48	10.71	7.90	5.81	4.26
.50	DISCHG	3.12	2.28	1.65	1.19	.85	.60	.41	.28	.17	.10
.00	DISCHG	.04	.01	.00							

RUNOFF VOLUME ABOVE BASEFLOW = 3.95 WATERSHED INCHES, 4917.94 CFS-HRS, 406.42 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

: ATION RESVOR STRUCTURE 1

PEAK TIME(HRS) PEAK DISCHARGE(CFS) PEAK ELEVATION(FEET)
13.58 1412.51 504.94

IMF(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .25 HOURS DRAINAGE AREA = 1.93 SQ.MI.

.00	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
2.50	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.00	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
5.[illegible]	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
[illegible]	DISCHG	.05	.05	.05	.05	.05	.05	.05	.06	.06	.06
.50	ELEV	499.61	499.62	499.63	499.66	499.69	499.74	499.79	499.86	499.95	500.03
10.00	DISCHG	.06	.06	.06	.07	.07	.07	.07	.07	.08	11.99
10.00	ELEV	500.11	500.19	500.29	500.41	500.56	500.73	500.90	501.11	501.47	502.08

TR XEQ 11/16/93 West Boggs Lake - 100 year 24 hour storm hydrograph for the 1 JOB 1 PAGE 1
REV 09/01/83 area 1 lake drainage area. Assumptions = starting elev. =499.6 PAGE 3

12.50	DISCHG	159.85	436.29	731.46	1146.55	1396.72	1342.59	1177.72	1001.56	878.14	776.34
12.50	ELEV	502.83	503.63	504.33	504.78	504.93	504.90	504.79	504.67	504.55	504.41
.00	DISCHG	698.44	624.02	559.99	499.17	446.68	399.69	358.29	322.46	291.85	265.85
10.00	ELEV	504.27	504.12	503.96	503.81	503.66	503.53	503.41	503.30	503.22	503.14
17.50	DISCHG	243.79	225.00	208.85	194.78	182.37	171.42	161.79	153.56	147.22	141.45
.50	ELEV	503.08	503.02	502.98	502.94	502.90	502.87	502.84	502.81	502.79	502.77
.00	DISCHG	136.29	131.65	127.34	123.12	118.89	114.65	110.48	106.53	102.92	99.73
20.00	ELEV	502.75	502.73	502.71	502.70	502.68	502.66	502.65	502.63	502.62	502.61
22.50	DISCHG	96.99	94.67	92.74	91.14	89.83	88.77	87.81	86.72	85.04	82.26
.50	ELEV	502.60	502.59	502.58	502.57	502.57	502.57	502.56	502.56	502.55	502.54
25.00	DISCHG	77.99	74.07	69.51	64.17	58.40	52.56	46.88	41.42	36.40	31.84
25.00	ELEV	502.52	502.50	502.47	502.43	502.39	502.35	502.31	502.28	502.24	502.21
.50	DISCHG	27.75	24.11	20.90	18.07	15.59	13.43	11.55	9.93	8.52	7.30
27.50	ELEV	502.18	502.16	502.14	502.12	502.10	502.09	502.08	502.07	502.06	502.05
30.00	DISCHG	6.25	5.35	4.57	3.91	3.34	2.85	2.44	2.08	1.78	1.52
30.00	ELEV	502.04	502.04	502.03	502.03	502.02	502.02	502.02	502.01	502.01	502.01
.50	DISCHG	1.30	1.11	.95	.81	.69	.59	.51	.43	.37	.32
32.50	ELEV	502.01	502.01	502.01	502.00	502.00	502.00	502.00	502.00	502.00	502.00
35.00	DISCHG	.27	.23	.20	.17	.14	.12	.11	.09	.08	.08
[illegible]	ELEV	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00
37.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
37.50	ELEV	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00
40.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
40.00	ELEV	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00
42.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
42.50	ELEV	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00
45.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
45.00	ELEV	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00	502.00
47.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
47.50	ELEV	502.00	502.00	502.00	502.00	502.00	502.00	502.00	501.99	501.99	501.99
50.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
50.00	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
52.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
52.50	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
55.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
55.00	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
57.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
57.50	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
60.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
60.00	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
62.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
62.50	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
65.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
65.00	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
67.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
67.50	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
70.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
70.00	ELEV	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99	501.99
72.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08

72.50	ELEV	501.99	501.99	501.99	501.99	501.98	501.98	501.98	501.98	501.98	501.98

NOFF VOLUME ABOVE BASEFLOW = 3.65 WATERSHED INCHES, 4547.83 CFS-HRS, 375.83 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 1, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

PERATION RUNOFF STRUCTURE 2

PEAK TIME(HRS) 13.72 PEAK DISCHARGE(CFS) 7091.44 PEAK ELEVATION(FEET) (RUNOFF)

I (HRS)		FIRST HYDROGRAPH POINT = .00 HOURS				TIME INCREMENT = .25 HOURS			DRAINAGE AREA = 11.34 SQ.MI.		
5.00	DISCHG	.00	.00	.00	.00	.00	.01	.12	.53	1.54	3.57
7.50	DISCHG	7.05	12.31	19.53	28.87	40.55	54.78	71.87	92.20	115.87	143.20
.00	DISCHG	174.32	209.61	250.17	298.10	356.80	431.59	541.34	770.07	1226.60	1971.15
..50	DISCHG	3009.31	4264.03	5502.49	6442.76	6962.68	7088.93	6880.79	6419.87	5760.98	5012.95
15.00	DISCHG	4344.11	3791.36	3328.41	2934.74	2594.18	2304.54	2061.60	1857.68	1685.27	1539.91
.50	DISCHG	1418.00	1315.01	1225.99	1148.80	1080.52	1018.82	962.59	912.08	868.40	830.67
	DISCHG	796.26	767.97	732.88	702.24	673.16	646.82	622.72	600.52	580.75	563.73
22.50	DISCHG	549.63	538.56	530.00	523.25	517.93	513.65	509.30	501.77	488.27	465.77
25.00	DISCHG	432.26	389.23	340.55	290.18	241.38	196.60	157.51	125.24	99.85	79.97
.50	DISCHG	64.06	51.25	40.87	32.59	25.96	20.66	16.46	13.09	10.41	8.25
30.00	DISCHG	6.51	5.10	3.97	3.05	2.32	1.74	1.27	.89	.57	.33
32.50	DISCHG	.15	.04	.00							

I NOFF VOLUME ABOVE BASEFLOW = 3.96 WATERSHED INCHES, 25968.52 CFS-HRS, 2393.96 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 2, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

PERATION ADDHYD STRUCTURE 2

PEAK TIME(HRS) 13.67 PEAK DISCHARGE(CFS) 8456.94 PEAK ELEVATION(FEET) 511.96

I (HRS)		FIRST HYDROGRAPH POINT = .00 HOURS				TIME INCREMENT = .25 HOURS			DRAINAGE AREA = 13.27 SQ.MI.		
.00	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.50	DISCHG	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
2.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
5.00	DISCHG	.05	.05	.05	.05	.05	.06	.17	.58	1.59	3.62
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.61	499.63	499.68	499.78
.50	DISCHG	7.10	12.35	19.58	28.92	40.60	54.83	71.92	92.25	115.93	143.26
	ELEV	499.96	500.14	500.26	500.42	500.60	500.71	500.83	500.97	501.13	501.28
	DISCHG	174.38	209.67	250.23	298.16	356.87	431.66	541.91	770.14	1226.67	1983.15
.00	ELEV	501.46	501.66	502.02	502.48	502.93	503.68	503.95	504.27	504.73	505.46
12.50	DISCHG	3169.17	4700.33	6233.95	7589.30	8359.40	8431.52	8058.52	7421.44	6639.12	5789.29
10.50	ELEV	506.67	508.20	509.73	511.09	511.86	511.93	511.56	510.92	510.14	509.29

5.00	DISCHG	5042.55	4415.88	3888.40	3433.91	3040.86	2704.23	2420.09	2180.14	1977.12	1805.76
15.00	ELEV	508.54	507.92	507.39	506.93	506.54	506.20	505.92	505.68	505.48	505.31
.50	DISCHG	1661.79	1540.01	1434.84	1343.58	1262.88	1190.24	1124.38	1065.84	1015.64	972.11
.50	ELEV	505.16	505.04	504.93	504.84	504.76	504.69	504.62	504.57	504.52	504.47
20.00	DISCHG	932.55	895.63	860.21	825.36	792.05	761.46	733.21	707.05	683.67	663.46
20.00	ELEV	504.43	504.40	504.36	504.33	504.29	504.26	504.23	504.21	504.19	504.16
.50	DISCHG	646.62	633.23	622.74	614.39	607.77	602.42	597.11	588.49	573.31	548.03
22.50	ELEV	504.15	504.13	504.12	504.11	504.11	504.10	504.09	504.07	504.03	503.97
25.00	DISCHG	510.25	463.30	410.06	354.35	299.78	249.17	204.40	166.67	136.26	111.81
.00	ELEV	503.86	503.76	503.63	502.92	502.50	502.01	501.64	501.41	501.25	501.11
.50	DISCHG	91.81	75.36	61.77	50.65	41.55	34.09	28.01	23.02	18.93	15.55
27.50	ELEV	500.97	500.85	500.76	500.68	500.61	500.50	500.40	500.32	500.25	500.19
.00	DISCHG	12.76	10.45	8.54	6.96	5.66	4.59	3.71	2.97	2.36	1.85
.00	ELEV	500.15	500.11	500.03	499.95	499.88	499.83	499.79	499.75	499.72	499.69
32.50	DISCHG	1.45	1.16	.95	.81	.69	.59	.51	.43	.37	.32
32.50	ELEV	499.67	499.66	499.65	499.64	499.63	499.63	499.63	499.62	499.62	499.62
.00	DISCHG	.27	.23	.20	.17	.14	.12	.11	.09	.08	.08
.00	ELEV	499.61	499.61	499.61	499.61	499.61	499.61	499.61	499.60	499.60	499.60
37.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
[illegible]	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
[illegible]	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
40.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
45.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
45.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
47.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
50.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
52.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
55.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
57.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
57.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
60.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
62.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
65.00	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
67.50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
70.00	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
70	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60
7 50	DISCHG	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
7..50	ELEV	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60	499.60

RUNOFF VOLUME ABOVE BASEFLOW = 3.91 WATERSHED INCHES, 33516.27 CFS-HRS, 2769.78 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 2, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

P ATION RESVOR STRUCTURE 2

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
25.77	350.62	502.89

IME(HRS)		FIRST HYDROGRAPH POINT = .00 HOURS				TIME INCREMENT = .25 HOURS			DRAINAGE AREA = 13.27 SQ.MI.		
.50	DISCHG	.01	.02	.03	.05	.08	.12	.17	.24	.32	.43
.50	ELEV	499.60	499.60	499.60	499.60	499.60	499.61	499.61	499.61	499.62	499.62
10.00	DISCHG	.56	.72	.91	1.13	1.40	1.73	2.13	2.67	3.49	4.62
.00	ELEV	499.63	499.64	499.65	499.66	499.67	499.69	499.71	499.73	499.77	499.84
.50	DISCHG	6.94	10.35	18.79	29.47	43.67	70.47	98.70	128.53	165.10	197.16
12.50	ELEV	499.95	500.11	500.25	500.42	500.63	500.82	501.00	501.20	501.41	501.58
15.00	DISCHG	214.49	223.46	240.60	251.18	260.40	268.10	274.85	280.83	286.13	290.86
	ELEV	501.72	501.84	501.94	502.03	502.10	502.18	502.25	502.31	502.36	502.41
17.50	DISCHG	295.12	298.96	302.47	305.67	308.61	311.61	314.66	317.48	320.09	322.52
17.50	ELEV	502.45	502.49	502.52	502.56	502.59	502.61	502.63	502.65	502.67	502.69
.00	DISCHG	324.79	326.92	328.91	330.76	332.49	334.09	335.58	336.97	338.27	339.48
.00	ELEV	502.71	502.72	502.74	502.75	502.76	502.77	502.78	502.79	502.80	502.81
22.50	DISCHG	340.61	341.69	342.73	343.72	344.69	345.63	346.55	347.43	348.28	349.04
22.50	ELEV	502.82	502.83	502.83	502.84	502.85	502.85	502.86	502.87	502.87	502.88
.00	DISCHG	349.69	350.19	350.50	350.61	350.53	350.26	349.81	349.22	348.50	347.69
25.00	ELEV	502.88	502.89	502.89	502.89	502.89	502.89	502.88	502.88	502.88	502.87
27.50	DISCHG	346.81	345.86	344.85	343.81	342.74	341.64	340.52	339.38	338.23	337.07
.50	ELEV	502.86	502.86	502.85	502.84	502.83	502.83	502.82	502.81	502.80	502.79
30.00	DISCHG	335.91	334.74	333.56	332.39	331.21	330.03	328.86	327.68	326.51	325.34
30.00	ELEV	502.79	502.78	502.77	502.76	502.75	502.74	502.73	502.73	502.72	502.71
.50	DISCHG	324.17	323.00	321.34	320.68	319.53	318.38	317.23	316.09	314.93	313.81
.50	ELEV	502.70	502.69	502.68	502.68	502.67	502.66	502.65	502.64	502.64	502.63
35.00	DISCHG	312.68	311.53	310.43	309.44	308.53	307.62	306.71	305.81	304.91	304.01
35.00	ELEV	502.62	502.61	502.60	502.59	502.59	502.58	502.57	502.56	502.55	502.54
.50	DISCHG	303.11	302.22	301.33	300.44	299.55	298.67	297.79	296.91	296.04	295.17
37.50	ELEV	502.53	502.52	502.51	502.50	502.50	502.49	502.48	502.47	502.46	502.45
40.00	DISCHG	294.30	293.43	292.57	291.70	290.84	289.99	289.13	288.28	287.43	286.59
.00	ELEV	502.44	502.43	502.43	502.42	502.41	502.40	502.39	502.38	502.37	502.37
.50	DISCHG	285.74	284.90	284.06	283.22	282.39	281.56	280.73	279.90	279.07	278.25
42.50	ELEV	502.36	502.35	502.34	502.33	502.32	502.32	502.31	502.30	502.29	502.28
.00	DISCHG	277.43	276.61	275.80	274.99	274.18	273.37	272.56	271.76	270.96	270.16
.00	ELEV	502.27	502.27	502.26	502.25	502.24	502.23	502.23	502.22	502.21	502.20
47.50	DISCHG	269.37	268.57	267.78	266.99	266.21	265.42	264.64	263.86	263.08	262.31
47.50	ELEV	502.19	502.19	502.18	502.17	502.16	502.15	502.15	502.14	502.13	502.12
50.00	DISCHG	261.53	260.76	259.99	259.19	258.39	257.59	256.79	256.00	255.21	254.42
50.00	ELEV	502.12	502.11	502.10	502.09	502.09	502.08	502.07	502.07	502.06	502.05
52.50	DISCHG	253.63	252.84	252.06	251.28	250.51	249.73	248.96	248.19	247.42	246.66

52.50	ELEV	502.05	502.04	502.03	502.03	502.02	502.01	502.01	502.00	502.00	501.99
55.00	DISCHG	245.89	245.13	244.37	243.62	242.86	242.11	241.36	240.62	239.87	239.13
.00	ELEV	501.98	501.98	501.97	501.96	501.96	501.95	501.94	501.94	501.93	501.93
.50	DISCHG	238.39	237.65	236.92	236.19	235.45	234.73	234.00	233.28	232.55	231.84
57.50	ELEV	501.92	501.91	501.91	501.90	501.90	501.89	501.88	501.88	501.87	501.87
60.00	DISCHG	231.12	230.40	229.69	228.98	228.27	227.57	226.86	226.16	225.46	224.76
.00	ELEV	501.86	501.85	501.85	501.84	501.84	501.83	501.82	501.82	501.81	501.81
62.50	DISCHG	224.07	223.37	222.68	222.00	221.31	220.62	219.94	219.26	218.58	217.91
65.50	ELEV	501.80	501.79	501.79	501.78	501.78	501.77	501.77	501.76	501.75	501.75
.00	DISCHG	217.23	216.56	215.89	215.22	214.56	213.89	213.23	212.57	211.91	211.26
67.00	ELEV	501.74	501.74	501.73	501.73	501.72	501.72	501.71	501.70	501.70	501.69
67.50	DISCHG	210.61	209.95	209.31	208.66	208.01	207.37	206.73	206.09	205.45	204.81
.50	ELEV	501.69	501.68	501.68	501.67	501.67	501.66	501.66	501.65	501.65	501.64
.00	DISCHG	204.18	203.55	202.92	202.29	201.67	201.04	200.42	199.86	198.80	197.55
70.00	ELEV	501.63	501.63	501.62	501.62	501.61	501.61	501.60	501.60	501.59	501.59
70.50	DISCHG	196.50	195.46	194.43	193.40	192.37	191.35	190.34	189.33	188.33	187.33
.50	ELEV	501.58	501.57	501.57	501.56	501.56	501.55	501.55	501.54	501.54	501.53

RUNOFF VOLUME ABOVE BASEFLOW = 1.93 WATERSHED INCHES, 16567.69 CFS-HRS, 1369.15 ACRE-FEET; BASEFLOW = .00 CFS

--- HYDROGRAPH FOR STRUCTURE 2, ALTERNATE 1, STORM 1, ADDED TO OUTPUT HYDROGRAPH FILE ---

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 1 RECORD ID

EXECUTIVE CONTROL OPERATION ENDJOB RECORD ID

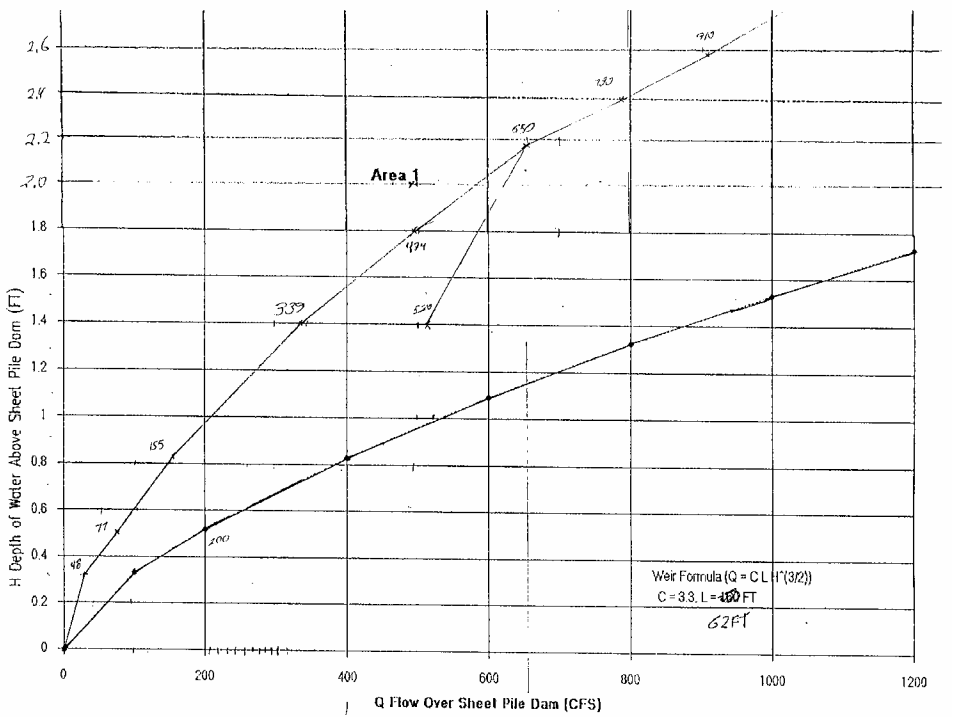
Appendix E

UMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

E ION/	STANDARD		RAIN	ANTEC	MAIN	PRECIPITATION			RUNOFF	PEAK DISCHARGE			
T CTURE ID	CONTROL OPERATION	DRAINAGE AREA (SQ MI)	TABLE #	MOIST COND	TIME INCREM (HR)	BEGIN (HR)	AMOUNT (IN)	DURATION (HR)	AMOUNT (IN)	ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 1													
CTURE 1	RUNOFF	1.93	2	2	.25	.0	6.31	24.00	3.95	---	13.17	1525.13	790.2
TRUCTURE 1	RESVOR	1.93	2	2	.25	.0	6.31	24.00	3.65	504.94	13.58	1412.51	731.9
TRUCTURE 2	RUNOFF	11.34	2	2	.25	.0	6.31	24.00	3.96	---	13.72	7091.44	625.3
CTURE 2	ADDHYD	13.27	2	2	.25	.0	6.31	24.00	3.91	511.96	13.67	8456.94	637.3
CTURE 2	RESVOR	13.27	2	2	.25	.0	6.31	24.00	1.93	502.89	25.77	350.62	26.4

UMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

SECTION/ STRUCTURE	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
STRUCTURE 2	13.27	
ALTERNATE 1		350.62
STRUCTURE 1	1.93	
ALTERNATE 1		1412.51


Area 1
H Depth of Water Above Sheet Pile Dam (FT)
Q Flow Over Sheet Pile Dam (CFS)
Weir Formula (Q = C L H^(3/2))
C = 3.3, L = 180 FT
62FT
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
0
200
400
600
800
1000
1200
48
71
185
339
474
539
650
730
910
100